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Effects of Sediment Addition on the Drift of Aquatic Macroinvertebrates in Nine Mile Creek, Nebraska

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EFFECTS OF SEDIMENT ADDITION ON THE DRIFT OF AQUATIC MACROINVERTEBRATES IN NINE MILE CREEK, NEBRASKA

by

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EFFECTS OF SEDIMENT ADDITION

ON THE DRIFT OF AQUATIC MACROINVERTEBRATES

IN NINE MILE CREEK, NEBRASKA

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Controlled additions of sediment, at approximately 200 mg/l, were added to Nine Mile Creek to study effects on drift rate of aquatic macroinvertebrates. Sediment was added for a two hour period, while drift nets were changed every fifteen minutes. Control and treatment channels were assembled in the stream on July 24 & 25, October 16 & 17, and November 6 & 7, 1982.

July sampling was during the irrigation season when return flow and flushing of Tri-State Canal increased background levels of suspended solids. The benthic community was very depauperate before the start of the experiment and additional amounts of suspended solids had a negligible effect.

In October and November riparian vegetation partially shaded the riffle area and influenced the growth of *Cladophora glomerata*. Experimental channels were established on both "*Cladophora*" and "non-*Cladophora*" portions of the riffle.

In October the "non-*Cladophora*" side showed an increase in drift of the treatment channels for Trichoptera early-instars, decreased drift for *Cricotopus trifascia* and Chironomid pupae, and no change for *Orthocladius obumbratus*, *O.* type III and *Simulium*. The

"*Cladophora*" portion showed decreased drift for all of these taxa in addition to *C. triannulatus*.

During early November the "non-*Cladophora*" side indicated an increase in drift for *O. obumbratus*, *C. trifascia*, *C. triannulatus*, *C. tremulus*, Chironomid pupae, Ephemeroptera early-instars and Hydropsychidae early-instars from the treatment channels. The "*Cladophora*" side again showed decreased drift of these taxa with the exception of Ephemeroptera early-instars, which generally remained the same during sediment addition.

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INTRODUCTION

Sediment deposition affects aquatic systems by decreasing light penetration, blanketing stream bottoms, and increasing the time needed for decomposition of organic matter (Ellis 1936). Recent studies have examined several different sources for erosional silt: logging practices (Tebo 1955), highway construction (Lenat, Penrose & Eagleson 1981), sediment release from reservoirs (Gray & Ward 1982), irrigation return flow (Peters 1978), and manufacturing (Nuttall & Bielby 1973). In addition, several experiments in the laboratory (Ciborowski, Pointing & Corkum 1977; McClelland & Brusven 1980) and in the field (Gammon 1970; White & Gammon 1976; Rosenberg & Snow 1975) have attempted to quantify the amount of sediment needed before adverse effects on aquatic macroinvertebrates are noted.

The objective of this study was to determine tolerance to sedimentation at the species level, by measuring changes in the drift rate between control and treatment channels. Sediment at a fixed concentration of 200 mg/l was artificially added to the treatment channels over a 2 hour period to simulate the initial phases of a runoff event.

METHODS & MATERIALS

Site Description

Nine Mile Creek, a groundwater-fed stream in the Nebraska panhandle, serves as spawning habitat for Rainbow trout (*Salmo gairdneri*). Adjacent land use includes sugar beets and corn, cattle grazing, and a Game & Parks Wildlife Management Area. During the irrigation season, early June to mid September, silt is washed into the stream by irrigation return flow and flushing of Tri-State Canal (Peters 1978).

The study site was a riffle area measuring approximately 7.5 meters wide by 20 meters long, upstream from a large concrete culvert. The riffle averaged 10 cm deeper on the northern side of the stream. Smooth brome grass (*Bromus inermis*), trees (cottonwood, *Populus deltoides*; and willow, *Salix* sp.) lined the creek bank. This vegetation, along with the east-west orientation of the stream, provided partial shading of the riffle area. This influenced the growth of *Cladophora glomerata* and an epiphytic population of diatoms within the stream during the fall months. On the shaded portion, or southern half of the riffle, *C. glomerata* was estimated to cover 10% of the substrate. On non-shaded areas (northern half) *C. glomerata* covered approximately 75% of the substrate.

Initial Set-up

Three experimental channels (1 control and 2 treatment) 60 cm in width, were formed from 5 meter long 5 cm x 29.5 cm planks. Fence posts to form the upstream end of the channels were driven into the substrate. The planks were attached and allowed to seek their own position in relation to the current. The downstream end was then secured with additional fence posts.

Sediment tubes were constructed of PVC pipe 2.3 cm diameter by 19.0 cm long with a plastic end cap attached with PVC glue. Tubes were driven almost flush with the substrate within the outer channels to measure the deposition of suspended solids. These were placed at 1, 3, and 5 meters and corked until the start of the experiment.

For each sampling period 2 "runs" were made on different sections of the riffle and tested only once. Each run was composed of 1 control and 2 treatment channels. Both channels and sediment tubes were set up the day before testing to allow macroinvetebrates time to resettle overnight, and to minimize debris accumulation and possible vandalism. For example, in the July sampling period (July 24 and 25) channels and sediment tubes for the first run were set up on the afternoon of July 23rd and tested July 24th. After sediment addition, these channels were disassembled, moved upstream approximately 7 meters, and reassembled the afternoon of July 24th for testing on July 25th. This general procedure was followed with October and November sampling periods. In October, sampling runs were adjacent to each other at the downstream end of the riffle. For

November, the first run was located on the southern half-upstream end of the riffle, while the second run was on the northern half-downstream end.

In this study a single concentration of 200 mg/l was used since this was roughly at the midpoint of summer data collected for this site by Peters (1978). Two hours of sediment addition was chosen since the intent was to measure pollution tolerance by time instead of concentration. This 2 hour period of testing was done at midday to avoid peak behavioral drift periods of sunrise and sunset. Sediment concentration was adjusted to the flow using a modification of the formula described by Rosenberg & Snow (1975):

$$A = 200\ \text{mg/l} \times B \times V \times 60\ \text{sec.} \times 15\ \text{min.}$$

A = addition rate (g/15 min.)
B = cross-sectional area of treatment channel (m^2)
V = average water velocity of treatment channel (m/sec.)

Flow was measured with a pygmy flow meter using standard U.S.G.S. methods. Sediment was obtained from fields in the area and represented typical soil of the watershed.

Three drift nets of 243 micron mesh were located at the downstream end of each channel and were changed every 15 minutes over the 2 hour period. Each net had a mouth opening of 10 x 10 cm. and was bolted horizontally onto a larger frame. This frame had hinges welded to the sides with short sections of tubing to fit over pipes secured at the end of each channel.

To apply the sediment in a uniform amount over time, a 114 liter trash can was modified to be a sediment mixer. Six hose connectors were fitted to the trash can with the upper 2 attached to hoses from the 2 water pumps. The lower 4 connectors were positioned horizontally, which gravity fed the sediment-water slurry through short hoses to the bottom of each treatment channel. Screen material of 500 micron mesh was placed over the pump intake hoses in the stream to prevent the accidental introduction of aquatic insects to the treatment channels. A measured amount of sediment adjusted to the flow was added over the top of the mixer. An electric stirrer was mounted on top to make the sediment-water slurry. A 110 volt generator supplied power for the water pumps and electric stirrer.

Laboratory Analysis

Water chemistry samples were taken at the downstream end of the treatment channels before and after the experiment and every 30 minutes during the 2 hours of sediment addition. The following parameters were sampled before, 60 minutes, and 120 minutes into the experiment, and after the experiment: pH, dissolved oxygen, temperature, conductivity, suspended solids and alkalinity. At 30 minutes and 90 minutes after the treatment started, suspended solids and conductivity were measured.

pH was measured with a portable pH meter, dissolved oxygen by the Winkler method, and temperature on site with an alcohol thermometer. A water sample for conductivity, suspended solids, and alkalinity was iced and transported to the lab for analysis.

Conductivity was measured with a conductivity meter. Suspended solids and alkalinity were determined according to Standard Methods (APHA 1980).

Substrate was sampled with a core device similiar in design to that used by McNeil and Ahnell (1964). These samples were taken 1 meter upstream of the channels before the start of each experimental run. In the laboratory, samples were first washed through a 125 micron sieve to remove silt and clay particles. Each portion of the sample was then oven dried at 105 C. Particles greater than 125 microns were dry sieved for 5 minutes through the following mesh sizes and weighed separately: 12 mm., 3.35 mm., 2.0 mm., 1.0 mm., 600 microns, 250 microns and 125 microns. Particles less than 125 microns were collectively weighed as one unit.

Sediment added to the stream was analyzed in a similiar manner, except only mesh sizes of 2.0 mm., 1.0 mm., 600 microns, 250 microns and 125 microns were used. Silt accumulation in the sediment tubes was measured by volume and dry weight. Weight measurements were further divided by particle size. Particles less than 500 microns represented sediment added during the experiment while larger particles generally represented the substrate.

Drift samples of macroinvertebrates were preserved in the field with formalin. In the laboratory, the sample was run through two sieves of 600 and 250 microns. All material retained by the 600 micron sieve was hand picked under a 7 to 30 power dissecting microscope. Material retained on the 250 micron sieve was floated for 10 minutes in a saturated salt solution and then examined under the same power dissecting microscope. Macroinvertebrates collected were placed in vials of 70% ethanol.

Benthic macroinvertebrates were collected with a Surber sampler having a mesh size of 243 microns and sampling 930 sq. cm. Before sediment addition, a benthic sample was taken 1 meter upstream of each channel. These were labeled the "before" benthic samples (BB). At the conclusion of the experiment, another benthic sample was taken within each channel 5 meters downstream of the previous samples. These were labeled as the "after" benthic samples (AB). Macroinvertebrates were preserved with formalin in the field. In the laboratory these samples were sorted using the same procedure as the drift samples. Chi-square was used to test community structure of each treatment "before" benthic sample to the control "before" benthic sample.

To facilitate size measurements in the laboratory, preserved macroinvertebrates were again washed over a 600 micron screen. The resulting two groups were separately measured and identified. Representatives of each taxon were measured for head capsule width. Identification was made to lowest possible taxonomic level with a dissecting microscope and a compound microscope. Chironomidae and small Simuliidae were mounted on glass slides with CMC-10 and identified under the compound microscope.

All organisms from drift samples were identified except when large numbers of Chironomids were encountered. In these cases at least 50% of the chironomids were mounted for identification. Due to variability in numbers of organisms for the benthic samples collected in October and November, a 50% subsample was sometimes used. Chironomidae were especially numerous in these benthic samples, and therefore, only 5 to 25% of the total were identified. Subsampling of benthic samples taken in July was not necessary.

RESULTS

Physical - Chemical

1. Substrate Analysis

Results from substrate analysis for 3 of the 5 samples, taken over the course of this study, were very similar (Appendix A.1). Both October runs and November second run had approximately 60% of the substrate by weight composed of gravel ($\geq$ 2 mm) or larger particles. Particles less than 600 microns (medium to fine sand and silt) ranged from 24% to 32%. November first run was composed of 80% gravel or larger material and 15% less than 600 microns in size. July substrate for the first run was composed of 98% of gravel size particles or larger. Substrate for July second run was not sampled.

Material used for sediment addition was composed primarily (99%) of particles less than 600 microns in size.

2. Flow Before and After Sediment Addition

Measurements were taken before and after sediment addition to determine any fluctuations in flow (Appendix A.2). Flows remained fairly uniform within each sampling period.

3. Water Pump Flow Increase and Sediment Concentration

Decreased stream flows during the fall months, and location of sampling runs, which influenced depth, contributed to the variation of flow increase caused by the water pumps. Both experimental runs for July and the second runs for October and November were similar in percent flow increase (4 or 5%) and a sediment concentration which ranged from 187 to 193 mg/l. In October the water pumps increased flow of the first run approximately 10%, reducing sediment concentration to 182 mg/l. In November, first run flow was increased by 26% and sediment concentration declined to 158 mg./l.

4. Water Chemistry

Most water chemistry parameters were unchanged over time from initial background readings (Appendix A.4). Suspended solids, as measured at the end of the channels, fluctuated during the 2 hour period of sediment addition (Appendix A.5). This difficulty in maintaining an even concentration was also noted by Rosenberg and Snow (1975) and Rosenberg and Weins (1978).

5. Sediment Tubes

Figure 1a shows July results for sediment concentration of particles less than 500 microns at their respective distances within the channels. Settling from sediment addition was uniform for the first run within the second treatment channel. All tubes were capped at the end of the 2 hour experiment.

For the second run, half of the sediment tubes of the treatment channel were capped after the first hour in order to further assess settling rates. In Figure 1a these numbers are listed in parenthesis. At 1 hour settling was slightly higher at 1 and 5 meters,

Figure 1. Sediment tube results of particles less than 500 microns in diameter taken at 1, 3, and 5 meters within the channel over a two-hour period. Parenthesis indicate sediment concentration in one hour. (1-C: First Control, 1-T: First Treatment, 2-T: Second Treatment, 2-C: Second Control, 3-T: Third Treatment, 4-T: Fourth Treatment).

First Run

2-T	1-T	1-C
73.23		1.83
81.42		4.14
78.68		2.18

flow

Second Run

4-T	3-T	2-C
77.02 (30.22)		1.33
62.09 (15.89)		2.27
102.88 (35.87)		27.60

a. July 24 and 25, 1982.

First Run

1-C	1-T	2-T
0.19		12.72 (5.70)
0.30		26.98 (11.03)
3.02	53.85 (4.41)	28.24 (6.01)

Second Run

2-C	3-T	4-T
0.58		57.28 (21.92)
1.38		29.00 (22.92)
1.12	25.43 (8.62)	17.92 (7.67)

b. October 16 and 17, 1982.

First Run

1-C	1-T	2-T
0.06		16.57 (9.21)
0.16		8.08 (3.56)
0.12	1.99 (2.91)	4.55 (2.23)

Second Run

2-C	3-T	4-T
3.53		89.84 (2.09)
36.69		9.77 (0.98)
2.73	9.61 (4.42)	9.52 (1.69)

c. November 6 and 7, 1982.

while at 2 hours settling was more pronounced at 5 meters. The control channel at 5 meters indicated a large amount of sediment, however this was due to spill-over from the adjacent treatment channel. The tube closest to this channel contained 54 grams while a nearby tube contained 1.16 grams.

In October, additional sediment tubes were placed at 5 meters of the second treatment channel. The first run at 1 hour showed a fairly uniform settling, but at 2 hours there was a greater buildup of sediment toward the middle and end of the channel (Fig. 1b).

The second run at 1 hour showed a trend of sediment build-up at 1 and 3 meters while at 2 hours this has shifted to 1 meter only. This most likely was due to the filamentous algae (Cladophora glomerata) on this side of the stream.

November first run for both 1 and 2 hours indicated a tendency for sediment to accumulate at the upper end of the treatment channels (Fig. 1c). One sediment tube at the downstream end of the first treatment channel had more sediment at 1 hour than the other tube for 2 hours.

The second run treatment channels had a fairly uniform distribution of sediment at 1 hour but at 2 hours this was confined more to the upstream end. As with the second run October, this was attributed to the presence of attached filamentous algae. One sediment tube at 3 meters in the control channel was affected by sediment from the adjoining treatment channel. This tube contained 72.4 grams while the other tube contained 0.98 grams.

Benthic Microdistribution

1. July

The benthic community for both runs was very sparse, and the sediment addition had no discernible effect (Appendix B.1 & B.2).

2. October

The first run was located on the southern, shaded half of the stream where growth of *C. glomerata* was limited. Chi-square was used to test community structure between control and each treatment "before" benthic sample. Due to low numbers of individuals in Plecoptera and Hydracarina (Table 1) these groups were combined with miscellaneous. Since the Chironomidae composed a major percentage of the community, this group was subdivided into *Orthocladius obumbratus*, *O.* type III, and other Chironomidae. Each treatment "before" benthic sample was significantly different from the control (X^2: $P<0.05$).

The second run on the northern half of the stream, was only partially shaded. Macroinvertebrate distribution among these samples (Table 2) indicated more variation in total numbers than among samples of the first run. In addition, within each channel, the downstream sample site had a greater abundance than the upstream site, despite sediment addition in the treatment channels. Community structure from the "before" benthic samples of each treatment channel was significantly different from the control (X^2: $P<0.05$).

Table 1. Abundance and percent community structure of macroinvertebrates from the benthic samples of the first run (October 16, 1982). (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample).

FIRST RUN

Taxa	1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Plecoptera	6 2%	12 2%	2 <1%	3 <1%	3 <1%	5 1%
Ephemeroptera	19 7%	54 8%	17 6%	26 7%	28 6%	33 8%
Trichoptera	51 17%	36 5%	8 3%	11 3%	18 4%	24 6%
Chironomidae	179 61%	550 77%	241 81%	329 85%	375 83%	304 76%
Simuliidae	24 8%	33 5%	9 3%	9 2%	13 3%	20 5%
Hydracarina	2 <1%	7 <1%	1 <1%	0 0%	1 <1%	3 <1%
Miscell.	11 4%	22 3%	21 7%	10 3%	12 3%	12 3%
Total	292	714	299	388	450	401

Table 2. Abundance and percent community structure of macroinvertebrates from the benthic samples of the second run (October 17, 1982). (2-C-BB: Second Control Before Benthic Sample, 4-T-AB Fourth Treatment After Benthic Sample).

SECOND RUN

Taxa	2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Plecoptera	13 5%	9 1%	0 0%	8 2%	7 2%	5 1%
Ephemeroptera	20 8%	83 11%	10 9%	72 19%	48 16%	22 6%
Trichoptera	57 23%	101 14%	8 7%	44 12%	45 15%	44 11%
Chironomidae	137 55%	444 61%	75 70%	204 54%	144 47%	282 72%
Simuliidae	6 2%	54 8%	6 6%	34 9%	21 7%	24 6%
Hydracarina	4 1%	15 2%	1 1%	6 1%	5 2%	7 2%
Miscell.	14 6%	24 3%	7 7%	12 3%	35 11%	10 2%
Total	251	730	107	380	305	394

The three "before" benthic samples from each run were combined to compare selected taxa from both sides of the stream (Table 3). Chironomidae were more abundant in the first run, due primarily to large numbers of *Orthocladius obumbratus*. *Orthocladius* type III was also a major contributor; collectively these two taxa made up 57% of the community. The second run was dominated by *O. obumbratus* and *Cricotopus trifascia*, making up 30% of the community.

3. November

The first run was again located on the southern, shaded half of the stream. Macroinvertebrates of this run are listed in Table 4. A chi-square test of each treatment "before" benthic sample was significantly different from the control sample (X^2: $P<0.05$).

The benthic samples of the November second run (Table 5) had a greater range in total numbers than the samples of the first run. This pattern was similar to October's second run. Each treatment "before" benthic sample was significantly different from the control (X^2: $P<0.05$).

Chironomidae were more numerous in the first run "before" benthic samples than the second run, due primarily to large numbers of *Orthocladius obumbratus* (Table 3). This same pattern was observed in October. *Cricotopus triannulatus*, *C. tremulus*, nr. *Parakiefferella*, *Baetis* and Ephemeroptera early-instars were also more numerous in the first run. In the second run *Orthocladius* type III was more abundant, a reversal of October's distribution.

Table 3. Abundance per taxa from the Before Benthic samples of each run for October 16 & 17, and November 6 & 7, 1982. (BB: Before Benthic sample, e.i.: early-instars).

Taxa	Oct. 16 Total BB 1st Run	Oct. 17 Total BB 2nd Run	Nov. 6 Total BB 1st Run	Nov. 7 Total BB 2nd Run
Orthocladius obumbratus	466	121	815	234
O. type III	127	59	163	350
Cricotopus trifascia	33	81	38	41
C. triannulatus	63	20	257	69
C. bicinctus	9	8	0	8
C. tremulus	9	4	262	53
Tvetenia bavarica g.	10	23	0	6
Eukiefferiella claripennis g.	7	0	0	0
Cardiocladius obscurus?	0	8	10	12
Thienemanniella	0	0	0	0
nr. Parakiefferiella	11	4	71	0
Chironomid pupae	60	26	138	76
Nematoda	7	16	51	30
Oligochaeta	22	13	45	16
Hydracarina	4	10	21	44
Asellus intermedius	1	15	10	1
Simulium	46	33	93	12
Isoperla	11	20	61	32
Hydropsyche simulans	46	59	36	79
Cheumatopsyche	5	8	18	3
Hydropsychidae(e.i.)	21	27	71	40
Hydroptila	1	8	4	8
Trichoptera(e.i.)	4	7	23	17
Baetis	25	20	147	13
Baetidae(e.i.)	18	23	22	11
Tricorythodes	6	15	54	25
Ephemeroptera(e.i.)	15	18	154	28
Uncommon taxa	31	41	171	59
total Chir.	795	356	1849	861
total non-Chir.	246	307	872	378
total	1041	663	2721	1239
Number of taxa	31	35	37	38

Table 4. Abundance and percent community structure of macroinvertebrates from the benthic samples of the first run (November 6, 1982). (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample).

FIRST RUN

Taxa	1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Plecoptera	8 1%	12 2%	37 4%	9 1%	16 1%	9 1%
Ephemeroptera	66 10%	68 9%	224 25%	55 8%	90 8%	58 8%
Trichoptera	47 7%	31 4%	82 9%	21 3%	24 2%	13 2%
Chironomidae	508 74%	572 79%	460 50%	585 80%	881 79%	566 82%
Simuliidae	22 3%	20 3%	54 6%	15 2%	19 2%	17 2%
Hydracarina	7 1%	3 <1%	12 1%	12 2%	2 <1%	1 <1%
Miscell.	30 4%	18 2%	48 5%	29 4%	84 8%	23 3%
Total	688	724	917	726	1116	687

Table 5. Abundance and percent community structure of macroinvertebrates from the benthic samples of the second run (November 7, 1982). (2-C-BB: Second Control Before Benthic Sample, 4-T-AB: Fourth Treatment After Benthic Sample).

SECOND RUN

Taxa	2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Plecoptera	16 4%	59 4%	13 3%	32 3%	3 <1%	24 3%
Ephemeroptera	29 7%	237 16%	37 8%	170 15%	15 4%	136 16%
Trichoptera	108 25%	234 16%	40 8%	119 11%	5 1%	55 6%
Chironomidae	230 54%	807 56%	326 69%	698 62%	305 89%	550 65%
Simuliidae	2 <1%	27 2%	8 2%	34 3%	2 <1%	21 2%
Hydracarina	27 6%	48 3%	14 3%	29 3%	3 <1%	34 4%
Miscell.	14 3%	38 3%	32 7%	34 3%	10 3%	31 4%
Total	426	1450	470	1116	343	851

Comparisons between Benthic Communities for October and November

While the total number of taxa were similar, the number of organisms in the "before" benthic samples, generally doubled by November (Table 3). *Orthocladius obumbratus* also showed this trend and remained the most dominant taxon for each sampling period. *Cricotopus trifascia* and *Simulium* generally remained the same in total numbers for each period, but decreased in rank, due to doubling in abundance of other organisms for November. *Cricotopus tremulus* made up a small portion of the community for October, but their numbers increased substantially by November (Table 3) making it one of the most abundant taxa.

Drift

1. July

Due to sparse population of benthos, only selected samples of the drift were identified to order or family level (Appendix C.1).

2. October

Of the three drift nets located at the end of each channel, 2 (nets A and C) were sorted and organisms identified to order or family level (Table 6).

Plecoptera and Hydracarina were sparse and therefore not included in further analysis of this run. Ephemeroptera and Simuliidae showed virtually no response to sediment addition, while Trichoptera showed at least a two fold increase in both treatment

Table 6. Abundance of macroinvertebrates from the drift samples of the first and second runs (October 16 & 17, 1982). (Ple.: Plecoptera, Eph.: Ephemeroptera, Tri.: Trichoptera, Sim.: Simuliidae, Chir.: Chironomidae, Hyd.: Hydacarina, Mis.: Miscellaneous, 1-C-TOTAL A & C: First Control Total of A&C Nets, 4-T-TOTAL A & C: Fourth Treatment Total of A&C Nets).

FIRST RUN

	Ple.	Eph.	Tri.	Sim.	Chir.	Hyd.	Mis.
1-C-TOTAL A&C	2	26	12	23	264	6	36
1-T-TOTAL A&C	2	16	36	24	179	6	29
2-T-TOTAL A&C	1	23	31	28	262	3	24

SECOND RUN

	Ple.	Eph.	Tri.	Sim.	Chir.	Hyd.	Mis.
2-C-TOTAL A&C	0	23	36	28	390	6	37
3-T-TOTAL A&C	0	9	13	8	125	2	17
4-T-TOTAL A&C	2	28	31	17	169	4	38

channels over the control. Chironomidae larvae and pupae were combined for analysis, but showed no response to sediment in the first run.

Analysis of Trichoptera to species was not possible for early-instars. Trichoptera early-instars increased in drift during sediment addition; however, due to small sample size for _H. simulans_ and early-instar Hydropsychidae, any interpretation of data for these two taxa is impractical (Appendix C.2). The range in head capsule width of these taxa, from Appendix D.1, are: _Hydropsyche simulans_ (0.6-1.1mm), Hydropsychidae early-instars (0.3-0.6mm), and Trichoptera early-instars (0.2-0.3mm).

Chironomidae made up 68% of the drift (Fig. 2). _Orthocladius obumbratus_ and _O._ type III indicated no response to silt, while _Cricotopus triannulatus_ showed a slight decrease in drift rate. _Cricotopus trifascia_ and Chironomid pupae indicated a more definite decline in drift rate (Fig. 2).

Major taxa at the order and family level for the second run are listed in Table 6. Ephemeroptera and Trichoptera at the order level showed no response to sediment addition, while early-instar Trichoptera indicated a slight decrease. Simuliidae also decreased in drift. As in the previous run, Plecoptera and Hydracarina were sparse.

Chironomidae showed a definite decrease in drift and were further analyzed to species (Fig. 3). _Orthocladius obumbratus_, _Cricotopus triannulatus_ and Chironomid pupae all showed a definite

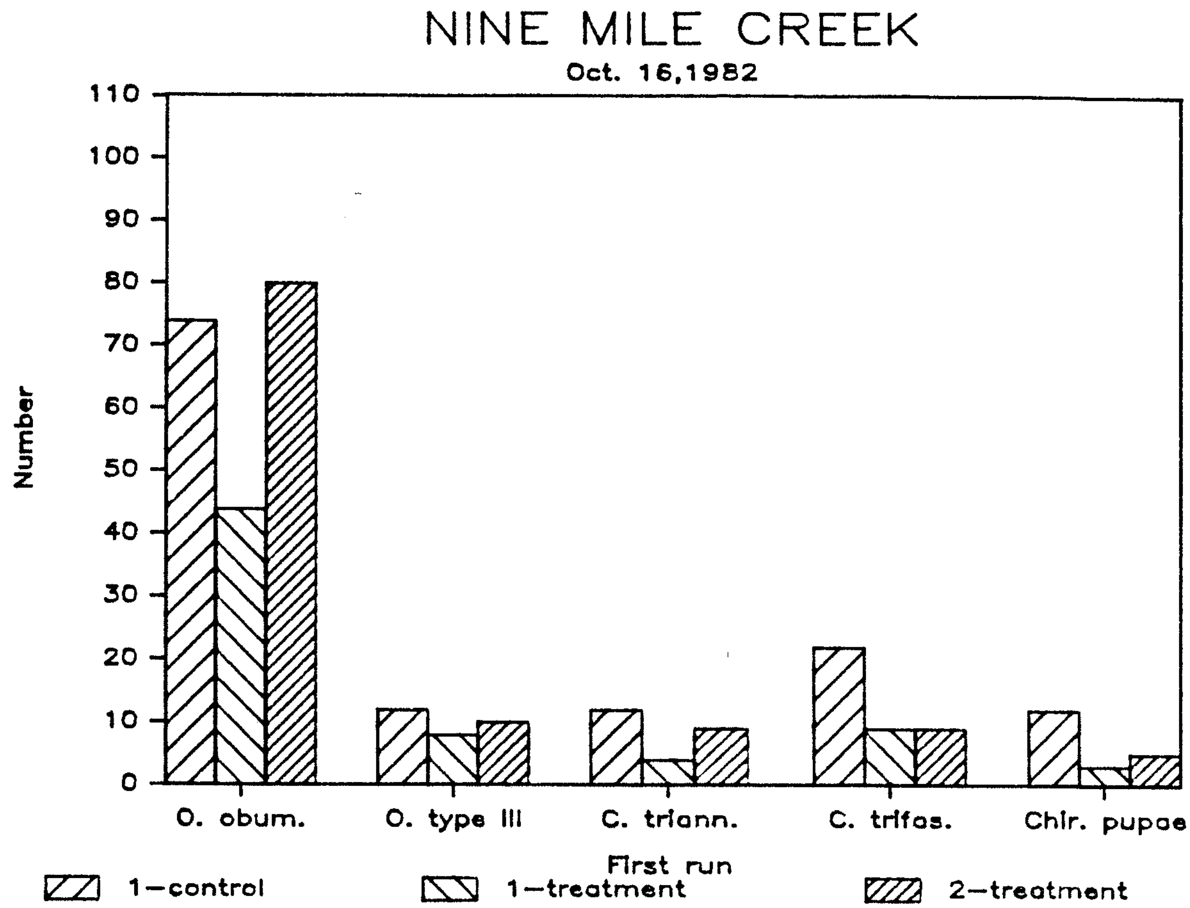

Figure 2. Selected Chironomid taxa in the drift for the first run October 16, 1982 (O. obum.: Orthocladius obumbratus, O. type III: Orthocladius type III, C. Triann.: Cricotopus triannulatus, C. trifas.: Cricotopus trifascia, Chir. pupae: Chironomid pupae).

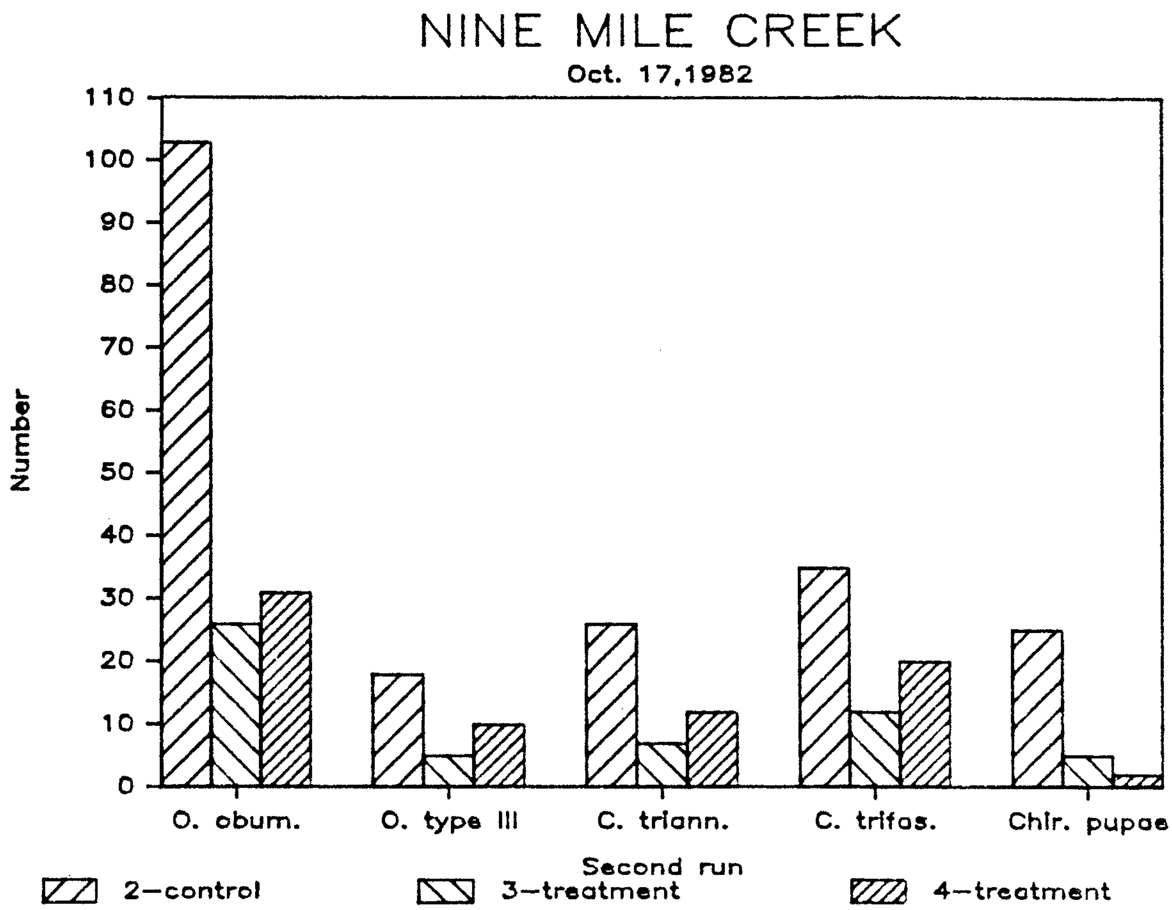

Figure 3. Selected Chironomid taxa in the drift for the second run October 17, 1982 (O. obum.: Orthocladius obumbratus, O. type III: Orthocladius type III, C. triann.: Cricotopus triannulatus, C. trifas.: Cricotopus trifascia, Chir. pupae: Chironomid pupae).

decrease in drift in the treatment channels as opposed to the control. Orthocladius type III and C. trifascia also showed a decrease (Fig. 3).

3. November

All major taxonomic groups of the first run showed an increase in drift for the treatment channels except Hydracarina which did not change (Table 7).

Plecoptera were represented by early-instars (head capsule width 0.2 to 0.4 mm.) which were difficult to identify further. However, only Isoperla has been collected in Nine Mile Creek (Peters 1978).

Ephemeroptera were identified to genus when possible, with average size for these taxa listed in Appendix D.3. The increase in drift noted for Ephemeroptera in Table 7 is primarily due to the early-instars of this order (head capsule width 0.2 to 0.5 mm). Trichoptera were identified further, when possible, with ranges in head capsule width of these taxa shown in Appendix D.3. Hydropsyche simulans, and early-instar Trichoptera showed a trend toward increased drift, but the most noticeable effect was expressed for early-instar Hydropsychidae (Appendix C.4).

Simuliidae had a different response for each sample net, with "A" net samples basically unchanged by sediment addition, while "C" net samples increased in drift. Organisms identified from "A" net belong to the genus Simulium.

Table 7. Abundance of macroinvertebrates from the drift samples of the first and second runs (November 6 & 7, 1982). (Ple.: Plecoptera, Eph.: Ephemeroptera, Tri.: Tichoptera, Sim.: Simuliidae, Chir.: Chironomidae, Hyd.: Hydracarina, Mis.: Miscellaneous, 1-C-TOTAL A & C: First Control Total of A&C Nets, 4-T-TOTAL A & C: Fourth Treatment Total of A&C Nets).

FIRST RUN

	Ple.	Eph.	Tri.	Sim.	Chir.	Hyd.	Mis.
1-C-TOTAL A&C	3	15	14	9	215	13	17
1-T-TOTAL A&C	16	66	70	21	519	7	43
2-T-TOTAL A&C	12	101	119	17	841	13	53

SECOND RUN

	Ple.	Eph.	Tri.	Sim.	Chir.	Hyd.	Mis.
2-C-TOTAL A&C	0	32	55	16	482	22	30
3-T-TOTAL A&C	2	37	27	23	235	7	31
4-T-TOTAL A&C	1	21	20	25	302	7	23

Drift of the six most dominant taxa of Chironomidae is graphed in Figure 4. All of these taxa showed some sensitivity to flow and sediment increase except Orthocladius type III.

The test area for the second run was approximately 5 meters downstream from the first and located on the northern half of the stream. This was due to disturbance from trout redds located adjacent to the first run. This downstream displacement meant that the second run was in approximately the same location as October's second run. Cladophora glomerata at this location did not appear to be as actively growing as in October.

Plecoptera were sparse (Table 7). Ephemeroptera and Simuliidae were essentially unchanged between the control and treatment channels. Trichoptera, Chironomidae and Hydracarina decreased in drift due to sediment addition. This decline was also noted for Chironomidae in the October second run.

Trichoptera such as Hydropsyche simulans and Hydroptila, were few in number, making any intrepretation difficult. Early-instars of Hydropsychidae and Trichoptera did show a decline in drift from the treatment channels. The ranges in head capsule widths of these taxa are listed in Appendix D.4.

Chironomidae were identified to species level with six major taxa shown in Figure 5. Orthocladius obumbratus, O. type III, Cricotopus tremulus, C. triannulatus and Chironomid pupae all showed a decrease in drift from the treatment channels.

October and November second runs indicated a decrease in drift for all Chironomid taxa listed in Table 8. November first run showed

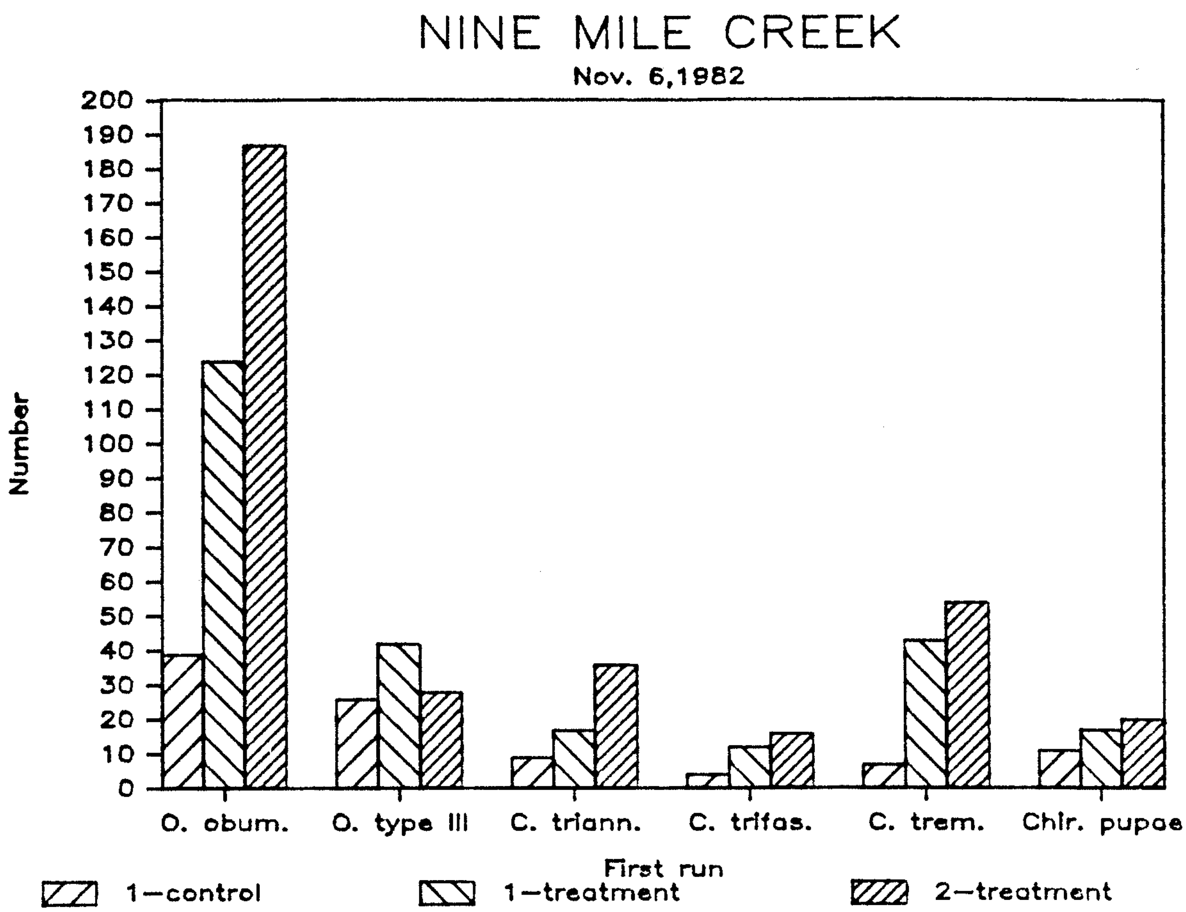

Figure 4. Selected Chironomid taxa in the drift for the first run November 6, 1982 (O. obum.: Orthocladius obumbratus, O. type III: Orthocladius type III, C. triann.: Cricotopus triannulatus, C. trifas.: Cricotopus trifascia, C. trem.: Cricotopus tremulus, Chir. pupae: Chironomid pupae).

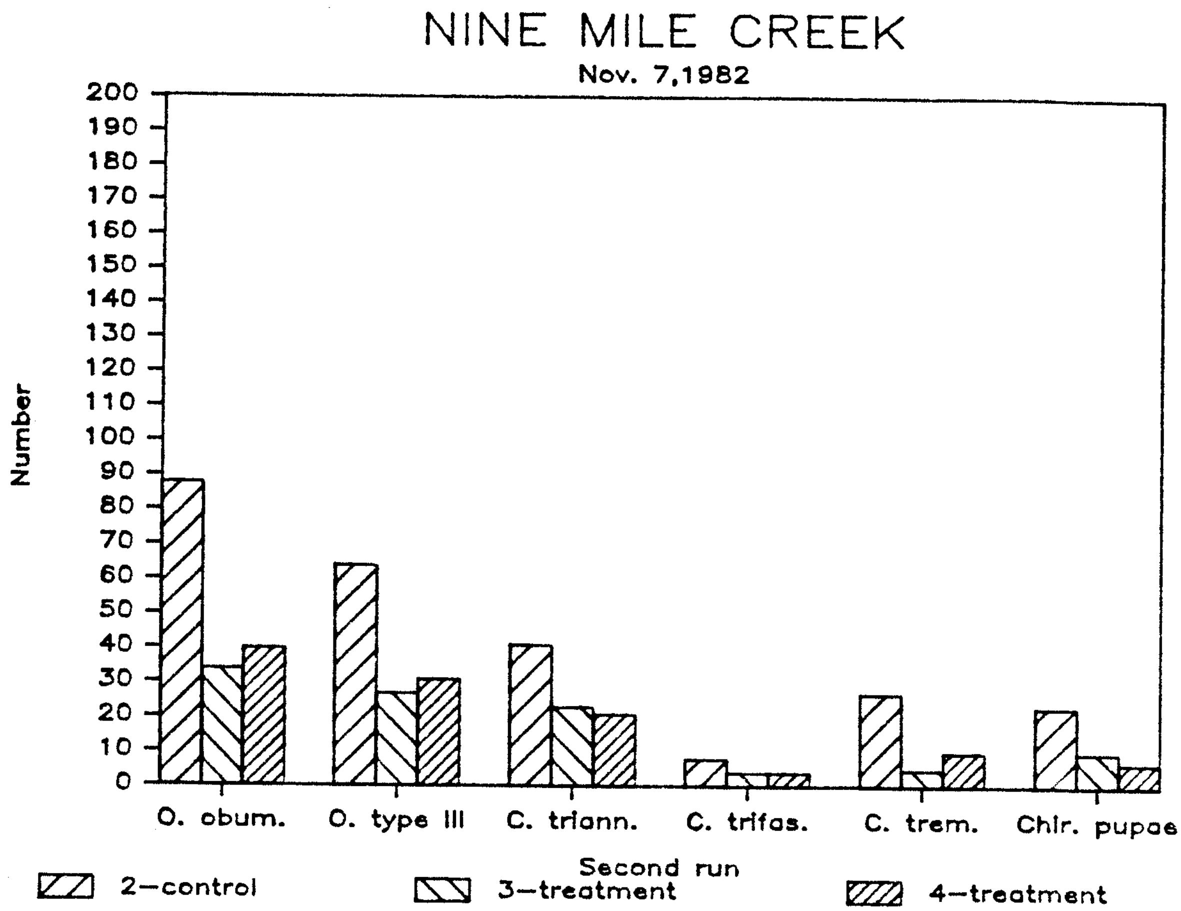

Figure 5. Selected Chironomid taxa in the drift for the second run November 7, 1982 (O. obum.: Orthocladius obumbratus, O. type III: Orthocladius type III, C. triann.: Cricotopus triannulatus, C. trifas.: Cricotopus trifascia, C. trem.: Cricotopus tremulus, Chir. pupae: Chironomid pupae).

Table 8. Summary of drift data from October 16 & 17, and November 6 & 7, 1982 comparing control and treatment channels.

Taxa	October First Run	October Second Run	November First Run	November Second Run
O. obumbratus	o	–	+	–
O. type III	o	–	o	–
C. trifascia	–	–	+	(–)
C. triannulatus	(–)	–	+	–
C. tremulus			+	–
Chironomid pupae	–	–	+	–
Ephemeroptera (early instars)			+	(o)
Hydropsychidae (early instars)			+	(–)
Trichoptera (early instars)	+	(–)	(+)	–
Simulium	o	–		
Hydracarina				–

Parenthesis only indicate a trend

– lower numbers in treatment channels than control

+ higher numbers in treatment channels than control

o similiar numbers in treatment and control channels an increase in drift, except for Orthocladius type III which was unchanged. October first run decreased in drift for three taxa and remained unchanged for O. obumbratus and O. type III.

DISCUSSION

Previous Research

Gammon (1970) added sediment for 15-minute periods and varied the concentration from 18 to 270 mg/l. He noted that drift rate increased roughly linearly up to 160 mg/l, then slowed, with the total macroinvertebrate fauna being similarly affected. Rosenberg and Snow (1975) also used 15-minute periods, but varied the concentration from 10 to 500 mg/l. Drift rate of Chironomidae increased with concentration, but was not linear. Ephemeroptera, Simuliidae and Hydracarina responses were not consistent. Gammon (1970) also noted a lag in response at greater concentrations, and it was suggested that a longer time interval (2 hours) would sort out the inconsistency in drift response reported by Rosenberg and Snow (1975). Rosenberg and Weins (1978, 1980) used 30 mg/l for a 5 hour period, but since I used a greater concentration (200 mg/l), it was presumed that a shorter time interval was justified.

In previous experiments, the channels were 15 meters or longer. Rosenberg and Snow (1975) reported that 85% of sediment added, had settled out within the first 7.5 meters. Therefore, in this study the channels were reduced to 5 meters so the entire length could be more equally exposed to sedimentation.

Benthic Microdistribution

1. July

July sampling was done in the middle of irrigation season (Peters 1978) when background levels of suspended solids averaged 60 mg/l. The benthic community was depauperate, averaging only three organisms per 930 cm^2 while drift numbered 16 organisms per 15-minute period. In the summer of 1977 macroinvertebrates were more abundant upstream of this site; however, in the summer of 1978 total numbers were similar (Peters 1987). In both summers total abundance of each sampling site was less than the winter months. In the Speed River, lower numbers of macroinvertebrates occurred in the summer, the usual emergence period of many species (Williams 1984).

The substrate sample of the site was 98 percent gravel or larger particles, while the flow velocity was approximately 0.8 m/sec. Hynes (1970) pointed out that even in turbid streams having low competance, this flow velocity should be high enough to move coarse sand particles from 0.5 to 1.0 mm in diameter.

Hynes (1973) noted that if concentrations of silt, sand, or clay did not often exceed 80 mg/l, then serious damage to a fishery is unlikely when permanent siltation can be avoided. Several investigators have looked at the effects of deposition on benthic communities (Rosenberg & Snow 1975; Ellis 1936; Nuttall & Bielby 1973) as opposed to suspended solids (Gammon 1970; White & Gammon 1976; Peters 1978; Gray & Ward 1982). A recent paper by Culp, Wrona and Davies (1986) showed that saltating sediments can also be the cause of catastrophic drift. In Nine Mile Creek during the summer months, the benthos was likely influenced by suspended solids, even though permanent siltation was avoided.

2. October and November

Background levels of suspended solids decreased substantially by October and November to 15 mg/l and 7 mg/l respectively. This reduced scouring action permitted the recolonization of fauna and flora of this site.

Chironomidae dominated the first runs for October and November, due primarily to large numbers of *Orthocladius obumbratus* (Table 3). *Orthocladius* type III was more numerous in the first run of October, but more abundant in the second run by November (Table 3).

Identification of Ephemeroptera and Trichoptera early-instars was difficult due to the lack of characteristic features. Mackay (1978) provided a key to Trichoptera early-instars for *Cheumatopsyche* and several species of *Hydropsyche*, however, *H. simulans* was not included. These early-instars were therefore left at the family or order level. *Hydropsyche simulans*, *Cheumatopsyche*, early-instar Hydropsychidae and early-instar Trichoptera all occurred in approximately equal numbers on the "*Cladophora*" and "non-*Cladophora*" portions of the stream for both months.

Ephemeroptera taxa and *Simulium* showed essentially equal utilization of both sides of the stream during October (Table 3). In November, *Baetis* and Ephemeroptera early-instars were more abundant on the "non-*Claudophora*" , or shaded side of the stream. Total abundance was higher for the first run (shaded side of the stream) for both October and November (Table 3).

Percival and Whitehead (1929) reported greater abundance of Chironomidae and *Hydroptila* on *Cladophora*, but *Baetis* preferred loose stones. *Hydropsyche* sp. occurred about equally on both types of habitat.

Two more recent studies, primarily on the effects of shading, were Hughes (1966), and Behmer and Hawkins (1986). Hughes (1966) reported that although certain species appeared to be influenced in their distribution, population density was minimally affected with no overall effect on any group or family between shaded and open portions of a stream. Hydracarina, Simuliidae and Chironomidae indicated no "preference", while *Hydroptila* was collected only at open stations. Hughes (1966) mentioned possible indirect effects of shading, such as algal growth, temperature, accumulation of organic debris and oviposition sites. Behmer & Hawkins (1986) noted much greater abundance at open sites for Chironomidae and two species of *Baetis*. Abundance of other taxa was also greater at open sites, but differences were not determined to be significant (ANOVA). Simuliidae tended to be more abundant on the shaded site, but again was not significant.

Chi-square tests of the "before" benthic samples, from the sampling runs of October and November, indicated that each treatment sample was significantly different from the control ($P<0.05$). This was expected, since the spatial dispersion of a population is frequently contagious, with the variance significantly greater than the mean (Elliott 1977). Needham and Usinger (1956) examined the variability of macroinvertebrates in a single riffle and stated that 73 samples would be needed to determine total numbers at the 95% level of significance (Latin Square). In addition, they noted that downstream position within the riffle was highly significant, while lateral position was not. Chutter (1972), in a reappraisal of Needham and Usinger's data found that the number of samples needed to estimate within 5% of the population mean was 292, not 73. Eighteen samples would be necessary to give an estimated mean within 20% of the population mean with a 95% level of confidence. The variability of the sample mean with 3 samples was $\pm$ 49%.

Density of macroinvertebrates and size of sampler (cm^2) could also influence number of samples needed (Downing 1979, Morin 1985). They noted that as the density and size of sampler decreased, the number of samples increased. Morin (1985) stated that at higher densities, stream benthos was more aggregated than lake benthos.

Drift

1. First and Second Run Differences for October and November

Table 8 indicates that for October and November the drift rate of organisms in the first run increased for some taxa, while other taxa decreased or remained unchanged during sediment addition. Drift rate of these same organisms decreased in the second run. White &

Gammon (1976) noted a decrease in drift of Simulium (mainly Simulium vittatum) until more than 100 mg/l of suspended solids were added. At higher concentrations the drift rate more than doubled over the control. Rosenberg and Weins (1980) also noted a decrease in drift of the Chironomid larvae Stempellinella sp. 1 and Constempellina sp. 2, while other genera were unaffected or increased.

In Nine Mile Creek this decrease was most likely due to extensive growth of Cladophera glomerata on the substrate of the second run. This could be due to 1) decreased drift distance, since aquatic plants could act as a natural sieve (Elliott 1967); 2) habitat increase (Minshall 1984; Iversen et al. 1985) and therefore alternate attachment sites; or 3) protection against current (Iversen et al. 1985) and so decreased exposure to sedimentation. Sediment tubes (Fig. 1) indicated that greater sedimentation did occur at the upper ends of the treatment channels of the second runs. Percival and Whitehead (1929) noted similar findings with Cladophora spp. holding up movement of fine and coarse sand (1.0-0.25 mm. diameter).

2. Differences Between First Runs October and November

While the drift responses of the second runs were similar, the first runs were not (Table 8). An interaction between increased current velocity and sediment addition in November's first run was most likely the cause of these differences. Ciborowski, Pointing and Corkum (1977) noted an interaction between increased current velocity and sediment addition had a greater effect on drift rate than each one separately. Water pumps on the sediment mixer increased flow volume by 10% and reduced sediment concentration to 182 mg/l in October, while November's flow volume was increased 26% and sediment concentration declined to 158 mg/l. Increasing flow velocity itself could increase drift numbers (Ciborowski, Pointing & Corkum 1977; Irvine 1985), and although flow velocity was not measured during sediment addition, it could be hypothesized that November's first run should have experienced the greatest percent increase, since its initial velocity was the lowest (Appendix A.2).

Another cause for first run differences could be a seasonal response, such as temperature (Rosenberg & Weins 1980) or life history (Rosenberg & Weins 1978; Gray & Ward 1982; Williams 1984). Rosenberg and Weins (1980) noted greater drift in Chironomidae in summer than fall and surmised that higher water temperatures may have increased their sensitivity. The reverse was observed in this study, however; current velocity may have had a greater effect. Life history can be affected by fluctuations in sediment release by selecting for species that have rapid colonization and larval development (Gray & Ward 1982). Nine Mile Creek does experience such fluctuations during the summer (Peters 1978). Another way for species to avoid sedimentation could be to "ride-it-out" in the hyporheic zone as early-instar larvae or more commonly as diapausing eggs (Williams 1984). In the Speed River, Williams (1984) reported that _Cricotopus_ and _Cladotanytarsus_ dominated the interstices in late summer, while _Microtendipes_ and _Orthocladius_ dominated in the winter. Rosenberg and Weins (1978) noted that the hyporheic zone might later act as a source of organisms to recolonize the benthos when favorable conditions return. Number of organisms increased greatly from July to October, and doubled again by November (Table 5). That in November, the stream could support this population may indicate that during October the substrate was not at carrying capacity, and therefore, during sediment addition alternative habitat sites were available.

3. Indicator Organisms

Early-instars of some species of Trichoptera have been noted to drift more than their older counterparts (Anderson 1967; Fjellheim 1980). In particular, two species of Hydropsychidae, Parapsyche cardis and Diplectroma modesta, were reported by O'Hop and Wallace (1983) to disperse as first instars, while few later instars drifted. An increase in drift of early-instar Trichoptera and Hydropsychidae in November first run (Table 8) may demonstrate that these taxa are useful as indicator organisms to the influence of sediment and/or flow velocity.

Muller (1974) observed an increase in drift of early-instar Baetids and Simulids, and Chebanova (1985) noted similar results for some species of Chironomidae. In Nine Mile Creek, Ephemeroptera early-instars occurred primarily in November, and an increase in drift was noted only for the first run (Table 8). Resh and Unzicker (1975) stressed the importance of species identification in water quality monitoring, since different species within the same genus can have different pollution tolerances. Therefore, use of early-instars as indicator organisms may be valid only in streams dominated by Hydropsychids (Hydropsyche simulans and Cheumatopsyche) and Baetids (Baetis sp.), such as Nine Mile Creek. Harris and Lawrence (1978) noted that H. simulans was found in streams having turbidity from 25 to 405 J.T.U. and total suspended solids from 26 to 568 mg/l. Cheumatopsyche campyla was found in streams having 0.3 to 180 J.T.U. Lenat, Penrose and Eagleson (1981) listed Cheumatopsyche, H. betteni and H. sparna as sediment tolerant. Baetis tricaudatus was described by Hubbard and Peters (1978) as mesolichtophilus and polylichtophilous to turbidity.

A literature search yielded little information on the pollution tolerance of Chironomidae, due primarily to lack of information on larval taxonomy (Simpson & Bode 1980). This was especially evident when species group was considered. Cricotopus triannulatus Macquart is listed by Beck (1977) as being eulichotophilus, but is only one species of nine in the C. tremulus group. Lenat, Penrose and Eagleson (1981), however, listed the C. tremulus group as being very tolerant to sediment (Table 9). More information was obtained for Orthocladius obumbratus, with a consensus that it was generally pollution sensitive (Simpson & Bode 1980, Beck 1977, Mason 1974).

If a decrease in drift due to sediment addition is a measure of intolerance, then Cricotopus trifascia and C. triannulatus must at least have the same sensitivity as Orthocladius obumbratus (Tables 8 & 9). Drift rate of O. type III in both October and November first runs were unchanged, and therefore this taxon should be more tolerant

Table 9. Summary of selected references concerning pollution tolerance of chironomid species.

Orthocladius obumbratus Johannsen = saproxenous (1); rheophilic (1); saprophobic (2); eulichtophilous & mesolichtophilous (2); rheophilous rheobiontic (2); relatively pollution sensitive (5);

Orthocladius (Euorthocladius) = Intermediate sediment tolerance (4);
O. type III sensu Soponis =

Cricotopus trifascia g. = saproxenous (1); found in clean and polluted waters (3); rheophilous (3);

C. trifascia Edwards =

Cricotopus tremulus g. = very sediment tolerant (4);

C. tremulus Linnaeus =

C. triannulatus Macquart [C. exilis Joh. in Beck (1977) and Mason (1974)] = saprophobic (2); eulichtophilous (2); rheobiontic (2); intermediate pollution tolerance (5);

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(1) Simpson & Bode 1980
(2) Beck 1977
(3) Simpson, Bode & Albu 1983
(4) Lenat, Penrose & Eagleson 1981
(5) Mason 1974

than _O. obumbratus_. _Cricotopus tremulus_ only occurred in sufficient numbers for analysis in the November samples, but since this taxon responded similarly to _O. obumbratus_, they may have comparable sensitivities (Table 8).

SUMMARY

This study confirms the findings of Beck (1977) to the silt tolerance of Orthocladius obumbratus and Cricotopus triannulatus. Cricotopus trifascia and C. tremulus responded the same as O. obumbratus and therefore must be relatively sensitive to sedimentation. Orthocladius type III, on the "non-Cladophora" portions of the stream, showed no change in drift due to sediment addition. Lenat, Penrose and Eagleson (1981) list O. (Euorthocladius) as intermediate in tolerance to sediment, which also appears to describe O. type III.

Early-instars of Hydropsyche simulans, Cheumatopsyche, and possibly Baetis spp. may prove more useful as indicator organisms to sedimentation than their older counterparts. However, until the taxonomy is improved for early-instars there is the likelihood that one may be comparing different species at different life stages. Further research is needed to investigate this more fully.

Additional research is also needed on the effects of filamentous algae. While the initial intent of this study was not directed toward the influence of Cladophora glomerata, it was noted to have a pronounced effect on the drift rate of organisms exposed to sedimentation.

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Authors List

Orthocladius obumbratus Johannsen
O. type III sensu Soponis
O. oliveri Soponis
Cricotopus tremulus Linnaeus
C. bicinctus Meigen
C. triannulatus Macquart
C. trifascia Edwards
C. curtus Hirvenoja
Cardiocladius obscurus? Johannsen
Polypedilum convictum Walker
Dugesia tigrina Girard
Asellus intermedius Forbes
Hydropsyche simulans Ross
Brachycentrus occidentalis Banks
Heptagenia diabasia Burks
Ephoron leukon Williamson

Cladophora glomerata Kutzing

APPENDICES

Appendix A.1 Substrate composition by percent weight for July 24, October 16 & 17, and November 6 & 7, 1982 in Nine Mile Creek.

	July 24 1st Run	Oct. 16 1st Run	Oct. 17 2nd Run	Nov. 6 1st Run	Nov. 7 2nd Run
Sieve opening mm	Percent by weight	Percent by weight	Percent by weight	Percent by weight	Percent by weight
12.000	76	32	34	55	35
3.350	20	23	22	20	18
2.000	3	7	7	5	5
1.000	2	6	6	3	5
0.600	0	5	7	2	5
0.250	0	11	17	4	18
0.125	0	11	5	8	8
<0.125	0	4	2	3	6

Appendix A.2 Flow measurements for each channel taken before and after each sampling run for July 24 & 25, Oct. 16 & 17 and Nov. 6 & 7, 1982 in Nine Mile Creek.

Channel		depth (m.)	width (m.)	velocity (m.)	m3/ sec.
		July 24 & 25, 1982			
1-control	before	0.28	0.60	0.73	0.12
	after	0.28	0.60	0.70	0.12
1-treatment	before	0.30	0.60	0.79	0.14
	after	0.30	0.60	0.79	0.14
2-treatment	before	0.27	0.62	0.84	0.14
	after	0.27	0.62	0.82	0.14
2-control	before	0.30	0.64	0.89	0.17
	after	0.30	0.64	0.76	0.15
3-treatment	before	0.30	0.60	0.81	0.15
	after	0.30	0.60	0.75	0.13
4-treatment	before	0.27	0.68	0.90	0.17
	after	0.27	0.68	0.84	0.15
		Oct. 16 & 17, 1982			
1-control	before	0.21	0.55	0.71	0.08
	after	0.20	0.55	0.82	0.09
1-treatment	before	0.16	0.50	0.73	0.06
	after	0.16	0.50	0.68	0.05
2-treatment	before	0.14	0.62	0.69	0.06
	after	0.16	0.62	0.62	0.06
2-control	before	0.23	0.61	1.01	0.14
	after	0.23	0.61	0.92	0.13
3-treatment	before	0.23	0.60	1.04	0.14
	after	0.21	0.60	1.00	0.13
4-treatment	before	0.27	0.59	0.97	0.15
	after	0.27	0.59	0.94	0.15
		Nov. 6 & 7, 1982			
1-control	before	0.12	0.62	0.63	0.05
	after	0.12	0.62	0.66	0.05
1-treatment	before	0.08	0.61	0.40	0.02
	after	0.09	0.61	0.46	0.03
2-treatment	before	0.09	0.59	0.47	0.03
	after	0.11	0.59	0.34	0.02
2-control	before	0.26	0.65	0.56	0.09
	after	0.24	0.65	0.63	0.10
3-treatment	before	0.27	0.63	0.61	0.11
	after	0.26	0.63	0.66	0.11
4-treatment	before	0.30	0.59	0.59	0.11
	after	0.29	0.59	0.74	0.13

Appendix A.3 Percent flow increase and actual sediment concentration in the treatment channels, due to increased water volume from the water pumps for July 24 & 25, October 16 & 17, and November 6 & 7, 1982 in Nine Mile Creek.

Channel	% flow increase	actual sed. con. mg/l
	July 24 & 25, 1982	
1-treatment	4	192
2-treatment	4	192
3-treatment	4	193
4-treatment	3	193
	Oct. 16 & 17, 1982	
1-treatment	10	182
2-treatment	10	182
3-treatment	4	192
4-treatment	4	193
	Nov. 6 & 7, 1982	
1-treatment	30	153
2-treatment	23	164
3-treatment	5	190
4-treatment	5	183

Appendix A.4 Water chemistry ranges for selected parameters during the two hours of sediment addition for July 24 & 25, October 16 & 17, and November 6 & 7, 1982 in Nine Mile Creek.

Parameters	July 24&25	Oct. 16&17	Nov. 6&7
pH	7.9-8.0	8.0-8.1	8.0-8.1
Temperature (C)	17.0-21.0	13.0-15.0	11.0-13.5
Dissolved Oxygen mg/l	8.1-8.6	9.1-9.4	9.9-10.6
Conductivity µmhos	650-700	600-700	-725-
Alkalinity mg/l	180-188	186-191	183-188

Appendix A.5 Suspended solids concentration (mg/l) for each channel over the two hour period of sediment addition for July 24 & 25, October 16 & 17, and November 6 & 7, 1982 in Nine Mile Creek.

Channel	Before	Time (minutes) 30	60	90	120	After
			July 24			
1-Treatment	65	112	91	99	123	
2-Treatment	66	91	90	83	165	
			July 25			
3-Treatment	56	69	85	101	82	
4-Treatment	59	65	78	107	85	
			Oct. 16			
1-Treatment	18	30	46	60	36	
2-Treatment	15	84	41	102	42	
1-Control						15
			Oct. 17			
3-Treatment	14	93	74	128	120	
4-Treatment	14	102	58	39	70	
2-Control						12
			Nov. 6			
1-Treatment	7	14	41	37	31	
2-Treatment	7	49	53	32	81	
1-Control						10
			Nov.7			
3-Treatment	8	35	40	38	27	
4-Treatment	7	44	29	12	12	
2-Control						5

Appendix B.1 Macroinvertebrates from the benthic samples for each channel of the first run (July 24, 1982) in Nine Mile Creek. (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample, e.i.: early-instars).

	FIRST RUN					
Taxa	1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Orthocladius type III						3
Cricotopus triannulatus		2				3
Other Chironomidae						1
Oligochaeta	2	1			1	1
Chelifera	1					
Baetis						2
Baetidae(e.i.)						1
Tricorythodes						2
Ephemeroptera(e.i.)		2				2
Total Chironomidae	0	2	0	0	0	7
Total Non-Chironomid	3	3	0	0	1	8
Total	3	5	0	0	1	15
Total number of taxa 9						

Appendix B.2 Macroinvertebrates from the benthic samples for each channel of the second run (July 25, 1982) in Nine Mile Creek. (2-C-BB: Second Control Before Benthic Sample, 4-T-AB: Fourth Treatment After Benthic Sample, e.i.: early-instars).

		SECOND RUN					
Taxa		2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Orthocladius type III		1					
Cricotopus trifascia		1					
Tvetenia bavarica g.		2					
Tanytarsus						1	
Oligochaeta		2					
Cladocera		3					
Hydroptila							1
Baetis			2		1		
Tricorythodes		1					
Total Chironomidae		4	0	0	0	1	0
Total Non-Chironomid		6	2	0	1	0	1
Total		10	2	0	1	1	1
Total number of taxa	9						

Appendix B.3 Macroinvertebrates from the benthic samples for each channel of the first run (Oct. 16, 1982) in Nine Mile Creek. (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample, e.i.: early-instars).

	FIRST RUN					
Taxa	1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Orthocladius obumbratus	106	238	138	183	222	171
O. type III	36	145	54	60	37	85
Cricotopus tremulus		12			9	12
C. bicinctus		12			9	9
C. triannulatus		19	24	47	39	12
C. trifascia	7	24	7	4	19	
Tvetenia bavarica g.	10	24				
Eukiefferiella claripennis g	7	12				
Cardiocladius obscurus?		7				
Thienemanniella		19				
nr. Parakiefferiella	2				9	
Lenziella				4		
Rheotanytarsus exiguus g.				9		
Thienemannimyia g.						4
Other Chironomidae				4		
Chironomid pupae	11	38	18	18	31	11
Nematoda	2	2	2	1	3	3
Oligochaeta	3	10	12	9	7	5
Collembola		2				
Dugesia tigrina		1				1
Hydracarina	2	7	1		1	3
Hydracarina sp.2			1			
Crangonyx	2		4		1	
Asellus intermedius		2	1			1
Hemiptera		1				
Chelifera		1			1	2
Hexatoma	1					
Simulium	24	32	9	9	13	20
S. bivittatum pupae		1				
Ceratopogonidae	1					
Caloparyphus		1				
Diptera pupae	2		1			
Coleoptera		2				
Isoperla	6	12	2	3	3	5
Hydropsyche simulans	32	23	3	5	11	16
Cheumatopsyche	3	4	1		1	3
Hydropsychidae(e.i.)	13	8	3	3	5	4
Hydroptila					1	
Hydroptilidae(e.i.)				1		
Trichoptera(e.i.)	3	1	1	2		1
Baetis	9	16	8	10	8	11
Baetidae(e.i.)	6	20	4	4	8	9
Tricorythodes	2	3	1	4	3	5
Rhithrogena ?		3				

Appendix B.3 Macroinvertebrates from the benthic samples for each channel of the first run (Oct. 16, 1982) in Nine Mile Creek. (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample, e.i.: early-instars).

Taxa		FIRST RUN 1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Ephoron leukon			2				
Ephemeroptera (e.i.)		2	10	4	8	9	8
Total Chironomidae		179	550	241	329	375	304
Total Non-Chironomid		113	164	58	59	75	97
Total		292	714	299	388	450	401
Total number of taxa	46						

Appendix B.4 Macroinvertebrates from the benthic samples for each channel of the second run (Oct. 17, 1982) in Nine Mile Creek. (2-C-BB: Second Control Before Benthic Sample, 4-T-AB: Fourth Treatment After Benthic Sample, e.i.: early-instars).

	SECOND RUN					
Taxa	2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Orthocladius obumbratus	49	121	29	81	43	85
O. type III	16	22	12	20	31	31
Cricotopus tremulus			2	12	2	7
C. bicinctus	4	11			4	7
C. triannulatus	8	39	8	40	4	24
C. trifascia	40	220	6	18	35	97
C. curtus				6		
Tvetenia bavarica g.	8		2	12	13	7
Cardiocladius obscurus?	4		4			7
nr. Parakiefferiella					4	
Pseudochironomus		6				
Lenziella		3		2		
Rheotanytarsus distinctissimus g.			2			3
Polypedilum convictum		3				
Chironomid pupae	8	19	10	13	8	14
Nematoda	6	5	2		8	1
Oligochaeta	4	6	1	4	8	2
Cyclopoida Copepoda					1	
Dugesia tigrina		3				
Hydracarina	4	15	1	6	5	7
Crangonyx	1		2	1	2	1
Amphipoda		1				
Asellus intermedius	1			2	14	2
Isopoda		3				1
Hemerodromia		3	1		1	
Hexatoma	1	3	1	1		
Simulium	6	54	6	34	21	24
Ceratopogonidae				1		
Caloparyphus	1			1		
Muscidae				1	1	
Isoperla	13	9		8	7	5
Hydropsyche simulans	35	40	4	19	20	13
Cheumatopsyche	5	2	1	2	2	
Hydropsychidae(e.i.)	11	34	1	14	15	8
Hydroptila	4	10	1	3	3	10
Brachycentrus occidentalis		2		2		3
Trichoptera(e.i.)	2	13	1	4	4	10
Trichoptera pupae					1	
Baetis	5	23	6	24	9	5
Baetidae(e.i.)	3	26	3	25	17	5
Ephemerella invaria g.			1	1		
Ephemerellidae(e.i.)				2		
Tricorythodes	8	12		10	7	3

Appendix B.4 Macroinvertebrates from the benthic samples for each channel of the second run (Oct. 17, 1982) in Nine Mile Creek. (2-C-BB: Second Control Before Benthic Sample, 4-T-AB: Fourth Treatment After Benthic Sample, e.i.: early-instars).

		SECOND RUN					
Taxa		2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Rhithrogena ?						1	
Heptageniidae(e.i.)			2				
Ephemeroptera(e.i.)		4	20		10	14	9
Eucoilidae							1
Scelionidae							2
Unknown					1		
Total Chironomidae		137	444	75	204	144	282
Total Non-Chironomid		114	286	32	176	161	112
Total		251	730	107	380	305	394
Total number of taxa	49						

Appendix B.5 Macroinvertebrates from the benthic samples for each channel of the first run (Nov. 6, 1982) in Nine Mile Creek. (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample, e.i.: early-instars).

	FIRST RUN					
Taxa	1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Orthocladius obumbratus	233	305	183	285	399	316
O. type III	81	77	46	87	36	26
Cricotopus tremulus	58	27	79	62	125	65
C. bicinctus						13
C. triannulatus	40	87	66	87	151	45
C. trifascia	29	13			9	13
Lopescladius						13
Cardiocladius obscurus?			10			
nr. Parakiefferiella				25	71	26
Rheotanytarsus distinctissimus g.	11	8	8			
Polypedilum convictum	11					
Cryptochironomus						7
Other Chironomidae		13	20		45	
Chironomid pupae	45	42	48	39	45	42
Nematoda	12	13	14	11	25	8
Oligochaeta	6		18	7	21	5
Hirudinea	1					
Dugesia tigrina	1		1		1	1
Planaria				1		
Hydracarina	7	3	12	12	2	1
Crangonyx	4	1	2		11	
Amphipoda				1		1
Asellus intermedius	2		2	5	6	4
Isopoda		1				
Chelifera	2	2	9	2	9	
Hemerodromia	1					
Hexatoma		1	2		9	4
Tipulidae	1				1	
Simulium	20	20	54	11	19	15
Simuliidae	2			4		2
Ceratopogonidae				1		
Caloparyphus				1		
Diptera					1	
Isoperla	8	12	37	9	16	9
Hydropsyche simulans	14	9	17	10	5	4
Cheumatopsyche	1	7	12	2	5	
Hydropsychidae(e.i.)	22	11	40	4	9	4
Hydroptila	3		1			
Brachycentrus occidentalis			1			4
Trichoptera(e.i.)	7	4	11	5	5	1
Baetis	12	11	96	2	39	4
Baetidae(e.i.)	1	8	19	22	2	17
Ephemerella invaria g.			3			

Appendix B.5 Macroinvertebrates from the benthic samples for each channel of the first run (Nov. 6, 1982) in Nine Mile Creek. (1-C-BB: First Control Before Benthic Sample, 2-T-AB: Second Treatment After Benthic Sample, e.i.: early-instars).

		FIRST RUN					
Taxa		1-C-BB	1-C-AB	1-T-BB	1-T-AB	2-T-BB	2-T-AB
Tricorythodes		11	11	23	2	20	11
Heptageniidae(e.i.)							2
Ephemeroptera(e.i.)		42	38	83	29	29	24
Total Chironomidae		508	572	460	585	881	566
Total Non-Chironomid		180	152	457	141	235	121
Total		688	724	917	726	1116	687
Total number of taxa	46						

Appendix B.6 Macroinvertebrates from the benthic samples for each channel of the second run (Nov. 7, 1982) in Nine Mile Creek. (2-C-BB: Second Control Before Benthic Sample, 4-T-AB: Fourth Treatment After Benthic Sample, e.i.: early-instars).

	SECOND RUN					
Taxa	2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Orthocladius obumbratus	59	225	93	233	82	180
O. type III	72	211	119	132	159	156
Cricotopus tremulus	18	75	25	159	10	37
C. bicinctus			8			
C. triannulatus	36	90	17	29	16	46
C. trifascia	6	105	25	58	10	63
Lopescladius			6			
Tvetenia bavarica g.	6			15		
Eukiefferiella claripennis g.						13
Cardiocladius obscurus?	12	15		6		
Rheotanytarsus distinctissimus g.	6					
Thienemannimyia g.				15		
Other Chironomidae		15				9
Chironomid pupae	15	71	33	51	28	46
Nematoda	5	4	21	13	4	6
Oligochaeta	9	26	6	6	1	6
Dugesia tigrina			1	2		6
Hydracarina	27	48	14	29	3	34
Crangonyx				4	2	
Amphipoda		2				
Asellus intermedius		1		4	1	10
Isopoda		1			1	
Chelifera					1	1
Hemerodromia				1		
Empididae				1		
Ephydridae		1				
Hexatoma		3	2	2		
Simulium	2	27	8	32	2	21
Simuliidae				2		
Caloparyphus			1	1		
Diptera						1
Microcylloepus						1
Coleoptera			1			
Isoperla	16	59	13	32	3	24
Hydropsyche simulans	60	83	17	52	2	20
Cheumatopsyche	2	11	1	5		8
Hydropsychidae(e.i.)	27	65	13	32		9
Hydroptila	5	19	3	5		3
Oxyethira			1			
Brachycentrus occidentalis	1		2	2	1	2
Brachycentridae(e.i.)	1					
Trichoptera(e.i.)	12	56	3	23	2	13
Baetis	1	13	9	22	3	24

Appendix B.6 Macroinvertebrates from the benthic samples for each channel of the second run (Nov. 7, 1982) in Nine Mile Creek. (2-C-BB: Second Control Before Benthic Sample, 4-T-AB: Fourth Treatment After Benthic Sample, e.i.: early-instars).

Taxa		SECOND RUN					
		2-C-BB	2-C-AB	3-T-BB	3-T-AB	4-T-BB	4-T-AB
Baetidae (e.i.)		2	37	6	25	3	32
Ephemerella invaria g.		1		2			
Ephemerellidae (e.i.)						1	4
Tricorythodes		17	30	8	7		4
Isonychia					2		
Rhithrogena ?							2
Heptageniidae (e.i.)					2		2
Ephemeroptera (e.i.)		8	157	12	112	8	68
Total Chironomidae		230	807	326	698	305	550
Total Non-Chironomid		196	643	144	418	38	301
Total		426	1450	470	1116	343	851
Total number of taxa	51						

Appendix C.1 Macroinvertebrates of selected drift samples for the first run (July 24, 1982) in Nine Mile Creek. (Ple.: Plecoptera, Eph.: Ephemeroptera, Tri.: Trichoptera, Ch.l.: Chironomid larvae, Ch.p.: Chironomid pupae, Sim.: Simuliidae, Hyd.: Hydracarina, Mis.: Miscellaneous, 1-C-15A: First Control 15 min. into run of A net, 1-T-120C: Second Treatment 120 min. into run of C net)

Channel & Net	Ple.	Eph.	Tri.	Ch.l.	Ch.p.	Sim.	Hyd.	Mis.
1-C-15A								
30A	0	4	2	8	1	1	1	12
45A								
60A								
75A	0	5	5	5	1	0	1	3
90A								
105A	0	0	2	9	0	0	1	5
120A	0	1	4	4	1	1	2	6
1-T-15A								
30A	0	2	1	7	0	2	1	4
45A	0	1	0	1	0	0	1	2
60A	0	2	1	0	0	1	2	3
75A	0	2	3	4	0	0	1	5
90A	0	1	0	7	0	0	2	2
105A	0	0	0	2	1	0	1	1
120A	0	5	1	4	0	1	1	3
2-T-15A								
30A								
45A								
60A	0	2	0	6	0	0	1	2
75A	0	4	2	4	1	0	0	6
90A	0	5	3	4	1	0	1	8
105A	0	3	0	5	1	0	2	3
120A	0	0	0	1	0	1	0	3

Appendix C.1 Macroinvertebrates of selected drift samples for the first run (July 24, 1982) in Nine Mile Creek. (Ple.: Plecoptera, Eph.: Ephemeroptera, Tri.: Trichoptera, Ch.l.: Chironomid larvae, Ch.p.: Chironomid pupae, Sim.: Simuliidae, Hyd.: Hydracarina, Mis.: Miscellaneous, 1-C-15A: First Control 15 min. into run of A net, 1-T-120C: Second Treatment 120 min. into run of C net)

Channel & Net	Ple.	Eph.	Tri.	Ch.l.	Ch.p.	Sim.	Hyd.	Mis.
1-C-15C	0	4	5	5	0	2	1	9
30C	0	2	2	6	2	2	2	8
45C								
60C	0	8	3	4	1	1	6	7
75C	0	3	8	8	0	4	3	4
90C	0	6	4	8	1	0	0	5
105C								
120C								
1-T-15C								
30C	0	3	3	10	1	3	1	5
45C	0	3	2	3	1	0	0	6
60C	0	5	1	3	0	0	0	4
75C	0	4	2	3	0	1	1	0
90C	0	3	1	3	0	0	0	2
105C								
120C	0	1	2	4	0	1	2	2
2-T-15C								
30C								
45C								
60C	0	5	2	2	1	0	1	1
75C								
90C	0	5	4	2	0	0	1	5
105C	0	4	2	1	0	0	1	2
120C	0	3	3	2	0	0	0	4

Appendix C.2 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (October 16, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN								
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Orthocladius obumbratus	1-C	18	10	7	7	8	10	4	10	74
	1-T	1	11	4	8	10	4	3	3	44
	2-T	10	7	10	13	9	12	6	13	80
O. type III	1-C	3	0	6	0	0	1	2	0	12
	1-T	2	1	1	1	1	1	1	0	8
	2-T	0	1	3	0	1	3	1	1	10
O. oliveri	1-C				0					0
	1-T				0					0
	2-T				1					1
Cricotopus tremulus	1-C	1	0	1	1				0	3
	1-T	0	2	1	0				0	3
	2-T	0	1	0	2				1	4
C. bicinctus	1-C		0			0				0
	1-T		0			1				1
	2-T		1			0				1
C. triannulatus	1-C		4	1	1	2	2	1	1	12
	1-T		1	2	0	1	0	0	0	4
	2-T		0	2	0	2	3	0	2	9
C. trifascia	1-C	0	2	6	3	3	2	2	4	22
	1-T	1	1	1	0	1	4	0	1	9
	2-T	2	2	0	1	2	1	0	1	9
Tvetenia bavarica g.	1-C	1	0	2		0	2	2	2	9
	1-T	0	1	0		0	0	0	0	1
	2-T	1	0	2		1	2	0	0	6
Eukiefferiella brehmi g.	1-C								1	1
	1-T								0	0
	2-T								0	0
E. claripennis g.	1-C								0	0
	1-T								1	1
	2-T								0	0
Cardiocladius obscurus?	1-C		1							1
	1-T		0							0
	2-T		0							0
Thienemanniella	1-C		0	1	0	1	0		0	2
	1-T		1	0	0	1	0		1	3
	2-T		0	2	1	2	1		1	7
nr. Parakiefferiella	1-C			1	0				0	1
	1-T			0	1				0	1
	2-T			0	0				1	1
Rheotanytarsus exiguus g.	1-C			1	1					2
	1-T			0	0					0
	2-T			0	0					0

Appendix C.2 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (October 16, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN								
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Chironomini	1-C			0						0
	1-T			1						1
	2-T			0						0
Thienemannimyia g.	1-C					1				1
	1-T					0				0
	2-T					0				0
Other Chironomidae	1-C		0		0	0	1		1	2
	1-T		1		0	0	0		0	1
	2-T		0		1	1	0		1	3
Chironomid pupae	1-C	3	1	1	0	2	2	3	0	12
	1-T	0	0	1	0	0	0	1	1	3
	2-T	1	0	1	0	0	0	0	3	5
Nematoda	1-C			1						1
	1-T			0						0
	2-T			0						0
Oligochaeta	1-C				1				1	2
	1-T				0				0	0
	2-T				0				0	0
Calanoid Copepoda	1-C	1		1						2
	1-T	0		0						0
	2-T	0		0						0
Ostracoda	1-C		0	0	0	2		3		5
	1-T		2	0	1	0		0		3
	2-T		0	1	0	0		0		1
Hydracarina	1-C	0	0				0		1	1
	1-T	1	1				1		0	3
	2-T	1	0				0		0	1
Hydracarina sp.2	1-C						0	0	1	1
	1-T						0	1	0	1
	2-T						1	0	0	1
Crangonyx	1-C	1	2			1	0	0	1	5
	1-T	0	0			0	0	1	0	1
	2-T	0	0			0	2	1	0	3
Asellus intermedius	1-C			0		1				1
	1-T			1		0				1
	2-T			0		0				0
Isopoda	1-C	0	0						0	0
	1-T	1	0						0	1
	2-T	0	1						1	2
Corixidae	1-C							0		0
	1-T							0		0
	2-T							1		1

Appendix C.2 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (October 16, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

					FIRST		RUN			
					Time (minutes)					
Taxa		15	30	45	60	75	90	105	120	total
Chelifera	1-C			0						0
	1-T			1						1
	2-T			0						0
Simulium	1-C	3	3	2	1		1	1	1	12
	1-T	2	0	2	1		1	5	0	11
	2-T	2	1	4	4		1	0	0	12
Caloparyphus	1-C							1		1
	1-T							0		0
	2-T							0		0
Pyralidae	1-C			0						0
	1-T			1						1
	2-T			0						0
Dytisidae	1-C	0								0
	1-T	0								0
	2-T	1								1
Laccophilus	1-C				1					1
	1-T				0					0
	2-T				0					0
Coleoptera	1-C					0				0
	1-T					1				1
	2-T					0				0
Isoperla	1-C	0			1			1	0	2
	1-T	0			0			0	1	1
	2-T	1			0			0	0	1
Hydropsyche simulans	1-C	0	1	0		0				1
	1-T	0	0	0		0				0
	2-T	1	0	1		1				3
Hydropsychidae(e.i.)	1-C				1	0		0	1	2
	1-T				1	0		1	0	2
	2-T				0	1		0	0	1
Hydroptila	1-C		0					0		0
	1-T		0					1		1
	2-T		1					0		1
Trichoptera(e.i.)	1-C	1	0	0		1	0	0	0	2
	1-T	1	2	1		4	1	1	4	14
	2-T	1	0	1		2	2	0	1	7
Calopterygidae	1-C		0							0
	1-T		0							0
	2-T		1							1
Baetis	1-C	1		1			3	1		6
	1-T	0		0			0	0		0
	2-T	0		0			0	0		0

Appendix C.2 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (October 16, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Baetidae(e.i.)	1-C	1	1	0	0				0	2
	1-T	0	1	1	0				1	3
	2-T	0	0	0	1				2	3
Tricorythodes	1-C				0		0	0		0
	1-T				0		1	1		2
	2-T				2		2	0		4
Ephemeroptera(e.i.)	1-C	0		1	0	1	1	0	0	3
	1-T	1		1	1	0	0	1	0	4
	2-T	1		1	1	0	2	0	1	6
Eucoilidae	1-C		0		1	0				1
	1-T		1		0	0				1
	2-T		0		0	1				1
Scelionidae	1-C				0	0		0	0	0
	1-T				1	0		1	1	3
	2-T				1	1		0	0	2
Diapriidae	1-C					0		1		1
	1-T					1		0		1
	2-T					0		0		0
Pteromalidae	1-C								1	1
	1-T								0	0
	2-T								0	0
Total Chironomidae	1-C	26	18	27	13	17	20	14	19	154
	1-T	4	19	11	10	15	9	5	7	80
	2-T	14	12	20	19	18	22	7	24	136
Total Non-Chironomid	1-C	8	7	6	6	6	5	8	7	53
	1-T	6	7	8	5	6	4	13	7	56
	2-T	8	4	8	9	6	10	2	5	52
Total	1-C	34	25	33	19	23	25	22	26	207
	1-T	10	26	19	15	21	13	18	14	136
	2-T	22	16	28	28	24	32	9	29	188

Total number of taxa 49

Appendix C.3 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (October 17, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

		SECOND			RUN					
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Orthocladius obumbratus	2-C	10	13	22	16	12	11	10	9	103
	3-T	6	4	4	2	2	3	2	3	26
	4-T	2	3	9	3	2	1	7	4	31
O. type III	2-C	1	5	2	2	2	3	2	1	18
	3-T	0	0	1	0	1	2	0	1	5
	4-T	0	1	1	1	1	4	2	0	10
Cricotopus tremulus	2-C	1		1		1				3
	3-T	0		0		0				0
	4-T	0		0		0				0
C. bicinctus	2-C			1	1			0		2
	3-T			0	1			0		1
	4-T			0	0			1		1
C. triannulatus	2-C	5	1	1	6	3	1	5	4	26
	3-T	1	0	2	0	0	1	1	2	7
	4-T	1	2	0	4	0	2	2	1	12
C. trifascia	2-C	5	2	9	3	4	7	3	2	35
	3-T	2	1	1	1	2	1	2	2	12
	4-T	5	3	0	2	3	1	3	3	20
Tvetenia bavarica g.	2-C	0		2	1		1	2	1	7
	3-T	0		0	0		0	1	0	1
	4-T	2		0	1		0	0	2	5
Eukiefferiella claripennis g.	2-C	1				1	1			3
	3-T	0				0	0			0
	4-T	0				0	0			0
E. devonica g.	2-C		2		1					3
	3-T		0		0					0
	4-T		0		0					0
Cardiocladius obscurus?	2-C	0								0
	3-T	1								1
	4-T	0								0
Thienemanniella	2-C	0		1		2		1		4
	3-T	0		2		0		0		2
	4-T	1		1		1		0		3
nr. Parakiefferiella	2-C								0	0
	3-T								1	1
	4-T								0	0
Rheotanytarsus exiguus g.	2-C						1			1
	3-T						0			0
	4-T						0			0
R. distinctissimus g.	2-C	1								1
	3-T	0								0
	4-T	0								0

Appendix C.3 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (October 17, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

		SECOND RUN								
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Other Chironomidae	2-C			1				0		1
	3-T			0				0		0
	4-T			0				1		1
Chironomid pupae	2-C	3	3	4	2	8	2	2	1	25
	3-T	0	0	0	0	1	0	2	2	5
	4-T	0	0	0	1	0	0	0	1	2
Nematoda	2-C			0		1	1	1		3
	3-T			0		1	0	1		2
	4-T			1		0	0	0		1
Oligochaeta	2-C	0		0			0	1		1
	3-T	0		0			0	0		0
	4-T	3		1			1	0		5
Collembola	2-C		0							0
	3-T		0							0
	4-T		1							1
Ostracoda	2-C	1				1	1	1		4
	3-T	0				0	0	0		0
	4-T	0				0	0	1		1
Hydracarina	2-C	1		1		0	2	1	0	5
	3-T	0		0		0	0	0	0	0
	4-T	0		0		1	0	0	1	2
Hydracarina sp.2	2-C		1		2	1	1	1	0	6
	3-T		0		0	0	0	0	1	1
	4-T		0		0	0	0	0	1	1
Crangonyx	2-C	1	1	1	0		1	0	0	4
	3-T	0	0	2	0		0	1	0	3
	4-T	0	2	0	1		0	1	1	5
Amphipoda	2-C	1							0	1
	3-T	0							1	1
	4-T	0							0	0
Corixidae	2-C				1					1
	3-T				0					0
	4-T				0					0
Chelifera	2-C								0	0
	3-T								0	0
	4-T								1	1
Hexatoma	2-C					0				0
	3-T					0				0
	4-T					1				1
Tipulidae	2-C									0
	3-T									0
	4-T									0

Appendix C.3 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (October 17, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

		SECOND RUN								
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Simulium	2-C	2	4	1	4	1		3	2	17
	3-T	2	0	0	0	0		0	1	3
	4-T	3	1	0	1	1		0	0	6
Simuliidae	2-C			2	0	1			1	4
	3-T			0	0	0			0	0
	4-T			0	1	0			0	1
Diptera	2-C			0	0					0
	3-T			0	1					1
	4-T			1	0					1
Prionoxystus	2-C				1					1
	3-T				0					0
	4-T				0					0
Haliplus	2-C		0							0
	3-T		0							0
	4-T		1							1
Hydropsyche simulans	2-C	0		1		0		0	0	1
	3-T	0		0		1		1	1	3
	4-T	1		0		0		0	0	1
Cheumatopsyche	2-C		0					0		0
	3-T		1					1		2
	4-T		0					0		0
Hydropsychidae(e.i.)	2-C	1	1	1	3	0	1	2	0	9
	3-T	0	1	0	0	1	0	0	1	3
	4-T	1	1	0	1	0	2	1	0	6
Hydroptila	2-C	1		1	0		0		1	3
	3-T	0		0	0		0		0	0
	4-T	0		0	1		1		0	2
Trichoptera(e.i.)	2-C	1	1		2	2	2	0		8
	3-T	0	0		0	0	0	1		1
	4-T	0	1		1	1	1	0		4
Trichoptera pupae	2-C								0	0
	3-T								1	1
	4-T								0	0
Baetis	2-C	1				1	1	0		3
	3-T	0				0	0	1		1
	4-T	0				1	0	1		2
Baetidae(e.i.)	2-C		0			1	1			2
	3-T		1			0	0			1
	4-T		1			1	2			4
Tricorythodes	2-C	0	0		1					1
	3-T	0	0		1					1
	4-T	1	1		0					2

Appendix C.3 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (October 17, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

		SECOND RUN								
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Ephemeroptera (e.i.)	2-C		1	2			2	0		5
	3-T		0	0			0	0		0
	4-T		0	0			0	1		1
Eucoilidae	2-C				0					0
	3-T				1					1
	4-T				0					0
Scelionidae	2-C						0			0
	3-T						0			0
	4-T						1			1
Diapriidae	2-C								1	1
	3-T								0	0
	4-T								0	0
Mymaridae	2-C			0		1				1
	3-T			1		0				1
	4-T			0		0				0
Hymenoptera pupae	2-C								0	0
	3-T								1	1
	4-T								0	0
Unknown	2-C	0					1			1
	3-T	1					0			1
	4-T	0					0			0
Total Chironomidae	2-C	27	26	44	32	33	27	25	18	232
	3-T	10	5	10	4	6	7	8	11	61
	4-T	11	9	11	12	7	8	16	11	85
Total Non-Chironomid	2-C	10	9	10	14	10	14	10	5	82
	3-T	3	3	3	3	3	0	6	7	28
	4-T	9	9	3	6	6	8	5	4	50
Total	2-C	37	35	54	46	43	41	35	23	314
	3-T	13	8	13	7	9	7	14	18	89
	4-T	20	18	14	18	13	16	21	15	135
Total number of taxa	49									

Appendix C.4 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (November 6, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN								
		Time in minutes								
Taxa		15	30	45	60	75	90	105	120	total
Orthocladius obumbratus	1-C	3	4	5	8	5	4	4	6	39
	1-T	5	7	15	12	15	24	21	25	124
	2-T	19	17	20	31	20	21	32	27	187
O. type III	1-C	3	7	2	2	6	2	2	2	26
	1-T	3	2	1	10	4	5	10	7	42
	2-T	0	4	2	3	2	4	7	6	28
Cricotopus tremulus	1-C	1	0	1	2	0	1	1	1	7
	1-T	9	3	3	5	7	4	6	6	43
	2-T	5	3	7	7	6	4	10	12	54
C. bicinctus	1-C			0						0
	1-T			0						0
	2-T			2						2
C. triannulatus	1-C	2	0	2	1	1	1	1	1	9
	1-T	0	0	1	4	2	2	4	4	17
	2-T	4	2	5	7	9	3	3	3	36
C. trifascia	1-C	1	1	0	1	0	0	1	0	4
	1-T	2	1	2	0	4	0	1	2	12
	2-T	2	3	2	2	2	0	0	5	16
Tvetenia bavarica g.	1-C	0						0	0	0
	1-T	1						0	0	1
	2-T	0						1	2	3
Eukiefferiella claripennis g.	1-C			0	0	0			1	1
	1-T			0	0	0			0	0
	2-T			2	0	2			0	4
Cardiocladius obscurus?	1-C			0	0					0
	1-T			2	1					3
	2-T			2	0					2
Thienemanniella	1-C	0	0	0					1	1
	1-T	0	0	0					0	0
	2-T	0	0	2					2	4
nr. Parakiefferiella	1-C	0				0	0	0	0	0
	1-T	0				0	0	1	0	1
	2-T	2				4	3	0	1	10
Pseudochironomus	1-C							0	0	0
	1-T							0	0	0
	2-T							1	0	1
Tanytarsus	1-C				0					0
	1-T				0					0
	2-T				1					1
Lenziella	1-C			0						0
	1-T			0						0
	2-T			1						1

Appendix C.4 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (November 6, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN Time in minutes								
Taxa		15	30	45	60	75	90	105	120	total
Rheotanytarsus exiguus g.	1-C		1	0	0					1
	1-T		0	0	0					0
	2-T		0	0	2					2
R. distinctissimus g.	1-C		0			0	0	0	0	0
	1-T		0			2	0	1	0	3
	2-T		1			0	0	0	0	1
Chironomini	1-C			0						0
	1-T			3						3
	2-T			0						0
Diamesa	1-C							0	0	0
	1-T							1	0	1
	2-T							0	0	0
Other Chironomidae	1-C	0	0	1	2	0	1			4
	1-T	0	0	0	3	2	0			5
	2-T	0	2	0	0	0	0			2
Chironomid pupae	1-C	3	1	2	0	2	2	0	1	11
	1-T	2	3	0	1	3	4	2	2	17
	2-T	3	3	0	3	6	3	1	1	20
Nematoda	1-C	0	1	2	0	0	0	0	0	3
	1-T	0	0	1	1	0	1	1	0	4
	2-T	0	0	3	0	0	1	0	1	5
Oligochaeta	1-C	1	0	1	0	2	0	1	2	7
	1-T	0	0	1	1	0	2	1	0	5
	2-T	2	1	3	1	1	1	2	3	14
Cyclopoida Copepoda	1-C				0					0
	1-T				1					1
	2-T				0					0
Hydracarina	1-C	1	0	1	0	2	0	0	1	5
	1-T	0	0	0	2	2	1	1	2	8
	2-T	0	0	1	0	0	3	0	1	5
Crangonyx	1-C	0	0	0	0	0	0	1	0	1
	1-T	0	1	1	0	0	1	1	0	4
	2-T	0	1	3	0	0	1	1	0	6
Amphipoda	1-C								0	0
	1-T								1	1
	2-T								0	0
Empididae	1-C			0			0			0
	1-T			2			1			3
	2-T			0			0			0
Simulium	1-C	0	0	0	2	2	0	0	0	4
	1-T	2	0	0	2	2	3	3	0	12
	2-T	0	1	0	0	0	1	0	3	5

Appendix C.4 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (November 6, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN Time in minutes								
Taxa		15	30	45	60	75	90	105	120	total
Diptera	1-C							0	0	0
	1-T							1	0	1
	2-T							0	0	0
Isoperla	1-C	0	0	0	0	0	0	1	0	1
	1-T	0	1	1	0	0	1	2	4	9
	2-T	0	0	0	0	3	1	1	1	6
Hydropsyche simulans	1-C	0	0	0	0	0	0	0	0	0
	1-T	1	0	0	0	1	2	1	0	5
	2-T	0	1	0	3	1	1	0	0	6
Cheumatopsyche	1-C					0				0
	1-T					0				0
	2-T					1				1
Hydropsychidae(e.i.)	1-C	0	0	0	1	0	0	1	0	2
	1-T	1	0	1	2	7	1	3	3	18
	2-T	2	2	4	6	5	5	1	9	34
Hydroptila	1-C			2	0	0				2
	1-T			0	0	1				1
	2-T			1	0	0				1
Hydroptilidae(e.i.)	1-C						0			0
	1-T						0			0
	2-T						1			1
Brachycentrus occidentalis	1-C					0				0
	1-T					0				0
	2-T					1				1
Trichoptera(e.i.)	1-C	0	0	0	0	0	1	0	0	1
	1-T	0	0	1	3	0	1	1	1	7
	2-T	0	0	1	1	0	2	0	2	6
Baetis	1-C				0	0	0	0	0	0
	1-T				1	1	1	0	0	3
	2-T				1	3	2	0	1	7
Baetidae(e.i.)	1-C	0	0			0				0
	1-T	0	0			0				0
	2-T	0	2			2				4
Ephemerella invaria g.	1-C							0	0	0
	1-T							1	0	1
	2-T							0	0	0
Tricorythodes	1-C	0	0	0	0	0	0	0	0	0
	1-T	0	0	0	0	0	0	1	0	1
	2-T	0	1	2	2	1	0	0	3	9

Appendix C.4 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the first run (November 6, 1982) in Nine Mile Creek. (1-C: First Control Channel, 1-T: First Treatment Channel, 2-T: Second Treatment Channel, e.i.: early-instars).

		FIRST RUN								
		Time in minutes								
Taxa		15	30	45	60	75	90	105	120	total
Ephemeroptera (e.i.)	1-C	2	2	1	0	2	1	0	0	8
	1-T	5	1	3	4	1	0	5	8	27
	2-T	2	2	3	1	1	3	0	3	15
Total Chironomidae	1-C	13	14	13	16	14	11	9	13	103
	1-T	22	16	27	36	39	39	47	46	272
	2-T	35	35	45	56	51	38	55	59	374
Total Non-Chironomid	1-C	4	3	7	3	8	2	4	3	34
	1-T	9	3	11	17	15	15	22	19	111
	2-T	6	11	21	15	19	22	5	27	126
Total	1-C	17	17	20	19	22	13	13	16	137
	1-T	31	19	38	53	54	54	69	65	383
	2-T	41	46	66	71	70	60	60	86	500
Total number of taxa	42									

Appendix C.5 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (November 7, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

		SECOND RUN Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Orthocladius obumbratus	2-C	13	8	7	16	17	14	6	7	88
	3-T	7	3	2	5	1	3	5	8	34
	4-T	5	3	8	6	3	7	4	4	40
O. type III	2-C	7	7	9	7	10	9	7	8	64
	3-T	5	2	4	1	6	3	3	3	27
	4-T	3	5	2	6	5	1	4	5	31
Cricotopus tremulus	2-C	6	4	4	0	5	2	4	2	27
	3-T	0	0	1	1	1	1	1	0	5
	4-T	5	1	0	0	1	1	1	1	10
C. bicinctus	2-C	3	0						1	4
	3-T	0	0						0	0
	4-T	0	2						0	2
C. triannulatus	2-C	0	3	8	9	5	7	5	4	41
	3-T	3	2	3	3	4	3	2	3	23
	4-T	7	1	4	2	0	2	2	3	21
C. trifascia	2-C	0	2	2	0	0	0	0	4	8
	3-T	0	0	0	1	2	0	1	0	4
	4-T	0	1	1	0	0	1	0	1	4
Tvetenia bavarica g.	2-C	0	1					0	1	2
	3-T	0	0					1	0	1
	4-T	0	0					0	0	0
Eukiefferiella claripennis g.	2-C	0	0	9	2	0	0	0	1	12
	3-T	0	1	0	0	0	0	0	0	1
	4-T	1	0	0	0	1	1	0	0	3
E. devonica g.	2-C	1							0	1
	3-T	0							1	1
	4-T	0							0	0
Cardiocladius obscurus?	2-C	0	1	0						1
	3-T	0	0	1						1
	4-T	0	0	0						0
Brillia	2-C	0								0
	3-T	0								0
	4-T	1								1
Thienemanniella	2-C					2				2
	3-T					0				0
	4-T					0				0
nr. Parakiefferiella	2-C			2	2	2	3			9
	3-T			0	0	0	0			0
	4-T			0	0	1	0			1
Pseudochironomus	2-C							1	0	1
	3-T							0	0	0
	4-T							0	0	0

Appendix C.5 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (November 7, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

		SECOND RUN								
		Time (minutes)								
Taxa		15	30	45	60	75	90	105	120	total
Tanytarsus	2-C						1			1
	3-T						0			0
	4-T						0			0
Paratanytarsus	2-C				0					0
	3-T				0					0
	4-T				1					1
Rheotanytarsus exiguus g.	2-C	3								3
	3-T	0								0
	4-T	0								0
R. distinctissimus g.	2-C							0	0	0
	3-T							1	0	1
	4-T							0	0	0
Chironomini	2-C			0						0
	3-T			1						1
	4-T			0						0
Other Chironomidae	2-C			2						2
	3-T			0						0
	4-T			0						0
Chironomid pupae	2-C	3	1	4	4	4	3	3	1	23
	3-T	0	1	2	1	1	2	3	0	10
	4-T	1	0	2	0	2	0	1	1	7
Nematoda	2-C	0	2	1	1	0	2	2	2	10
	3-T	1	0	2	1	0	0	0	1	5
	4-T	2	3	0	0	0	1	1	2	9
Oligochaeta	2-C	3	1			0	0	0	0	4
	3-T	0	1			0	1	6	0	8
	4-T	0	0			1	0	1	0	2
Hydracarina	2-C	0	3	2	1	3	1	0	3	13
	3-T	1	0	1	0	0	0	0	0	2
	4-T	0	0	1	1	2	0	0	0	4
Hydracarina sp.2	2-C	0								0
	3-T	1								1
	4-T	0								0
Asellus intermedius	2-C					0				0
	3-T					1				1
	4-T					0				0
Chelifera	2-C	0	1							1
	3-T	0	1							1
	4-T	0	0							0
Empididae	2-C						0	0	0	0
	3-T						1	1	0	2
	4-T						0	0	0	0

Appendix C.5 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (November 7, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

Taxa		SECOND RUN Time (minutes) 15	30	45	60	75	90	105	120	total
Simulium	2-C	2	3	0	0	2	1	1	1	10
	3-T	1	1	1	2	0	0	2	2	9
	4-T	1	0	3	3	0	1	1	1	10
Simuliidae	2-C	0	1			0	0	1	0	2
	3-T	0	0			1	0	0	0	1
	4-T	0	0			0	0	0	1	1
Pyralidae	2-C	1								1
	3-T	0								0
	4-T	0								0
Coleoptera	2-C					0				0
	3-T					1				1
	4-T					0				0
Isoperla	2-C				0					0
	3-T				1					1
	4-T				0					0
Hydropsyche simulans	2-C	0	1				0	0	1	2
	3-T	1	0				0	4	1	6
	4-T	0	0				1	0	0	1
Cheumatopsyche	2-C				1					1
	3-T				0					0
	4-T				0					0
Hydropsychidae(e.i.)	2-C	1	1	1	2	2	2	0	1	10
	3-T	0	0	2	0	0	2	1	1	6
	4-T	0	2	0	0	0	1	1	1	5
Hydroptila	2-C	0	0	0	0	0	0	1	0	1
	3-T	0	1	1	0	1	0	0	0	3
	4-T	0	0	0	0	0	0	1	0	1
Brachycentrus occidentalis	2-C	0	1							1
	3-T	0	0							0
	4-T	0	0							0
Trichoptera(e.i.)	2-C	1	2	1	1	2	2	1	4	14
	3-T	0	0	0	0	0	0	2	0	2
	4-T	0	0	0	1	0	1	0	0	2
Baetis	2-C	0	0	0	1			0	0	1
	3-T	0	0	0	0			0	0	0
	4-T	1	1	0	0			1	0	3
Baetidae(e.i.)	2-C	0	1	0	0	0	0	0	1	2
	3-T	1	1	0	0	1	0	3	0	6
	4-T	0	0	0	0	0	1	0	1	2
Tricorythodes	2-C	0	0	0	0	0	0			0
	3-T	0	1	0	1	0	1			3
	4-T	0	0	0	0	0	0			0

Appendix C.5 Macroinvertebrates from the drift samples of each channel over the two hour period of sediment addition for the second run (November 7, 1982) in Nine Mile Creek. (2-C: Second Control Channel, 3-T: Third Treatment Channel, 4-T: Fourth Treatment Channel, e.i.: early-instars).

Taxa		SECOND RUN Time (minutes) 15	30	45	60	75	90	105	120	total
Heptagenia diabasia	2-C							0	0	0
	3-T							1	0	1
	4-T							0	0	0
Ephemeroptera (e.i.)	2-C	0	2	0	2	0	0	2	2	8
	3-T	2	1	0	0	4	2	3	1	13
	4-T	1	0	0	0	0	0	1	0	2
Total Chironomidae	2-C	36	27	47	40	45	39	26	29	289
	3-T	15	9	14	12	15	12	17	15	109
	4-T	23	13	17	15	13	13	12	15	121
Total Non-Chironomid	2-C	8	19	5	9	9	8	8	15	81
	3-T	8	7	7	5	9	7	23	6	72
	4-T	5	6	4	5	3	6	7	6	42
Total	2-C	44	46	52	49	54	47	34	44	370
	3-T	23	16	21	17	24	19	40	21	181
	4-T	28	19	21	20	16	19	19	21	163
Total number of taxa	44									

Appendix D.1 Head capsule width range measurements of macroinvertebrates of the benthic and drift samples from the first run (October 16, 1982) in Nine Mile Creek. (Min.: Minimum, Max.: Maximum, e.i.: early-instars).

	FIRST			RUN		
		Benthic	Range		Drift	Range
Taxa	Sample Size	Min. (mm.)	Max. (mm.)	Sample Size	Min. (mm.)	Max. (mm.)
Simulium	11	0.3	0.6	8	0.4	0.6
Isoperla	14	0.3	0.9	4	0.4	0.5
Hydropsyche simulans	16	0.5	1.7	4	0.6	1.1
Cheumatopsyche	9	0.3	1.1			
Hydropsychidae(e.i.)	8	0.3	0.4	5	0.3	0.6
Hydroptila	1	0.3	-	2	0.2	0.4
Hydroptilidae(e.i.)	1	0.3	-			
Trichoptera(e.i.)	6	0.2	0.3	16	0.2	0.3
Baetis	12	0.4	1.1	5	0.6	1.1
Baetidae(e.i.)	10	0.4	0.6	8	0.3	0.6
Tricorythodes	11	0.3	0.6	4	0.4	0.6
Rhithrogena?	2	0.4	0.5			
Ephoron leukon	1	0.3	-			
Ephemeroptera(e.i.)	11	0.2	0.4	13	0.2	0.6

Appendix D.2 Head capsule width range measurements of macroinvertebrates of the benthic and drift samples from the second run (October 17, 1982) in Nine Mile Creek. (Min.: Minimum, Max.: Maximum, e.i.: early-instars).

	SECOND RUN					
	Benthic			Drift		
Taxa	Sample Size	Range Min. (mm.)	Range Max. (mm.)	Sample Size	Range Min. (mm.)	Range Max. (mm.)
Simulium	17	0.2	0.6	7	0.1	0.4
Isoperla	11	0.2	0.8			
Hydropsyche simulans	20	0.5	1.7	5	0.6	1.6
Cheumatopsyche	6	0.4	1.4	2	1.1	1.1
Hydropsychidae(e.i.)	13	0.2	0.5	17	0.2	0.4
Hydroptila	12	0.2	0.3	5	0.3	0.4
Brachycentrus occidentalis	4	0.3	0.7			
Trichoptera(e.i.)	9	0.2	0.4	10	0.2	0.3
Baetis	12	0.6	1.2	6	0.4	0.9
Baetidae(e.i.)	10	0.3	0.8	6	0.4	0.6
Ephemerella invaria g.	2	0.7	1.1			
Ephemerellidae(e.i.)	2	0.4	0.5			
Tricorythodes	13	0.3	1.2	4	0.4	0.6
Heptageniidae(e.i.)	1	0.4	-			
Rhithrogena?	1	0.4	-			
Ephemeroptera(e.i.)	9	0.3	0.4	4	0.3	0.4

Appendix D.3 Head capsule width range measurements of macroinvertebrates of the benthic and drift samples from the first run (November 6, 1982) in Nine Mile Creek. (Min.: Minimum, Max.: Maximum, e.i.: early-instars).

	FIRST			RUN		
		Benthic Range			Drift Range	
Taxa	Sample Size	Min. (mm.)	Max. (mm.)	Sample Size	Min. (mm.)	Max. (mm.)
Simulium	12	0.4	0.8	12	0.4	0.9
Isoperla	12	0.2	0.8	15	0.2	0.4
Hydropsyche simulans	16	0.5	1.7	10	0.5	1.4
Cheumatopsyche	9	0.4	1.9	1	0.6	-
Hydropsychidae(e.i.)	8	0.4	0.4	24	0.3	0.6
Hydroptila	1	0.3	-	2	0.3	0.3
Brachycentrus occidentalis	2	0.4	0.4	1	0.4	-
Trichoptera(e.i.)	4	0.2	0.3	10	0.2	0.3
Baetis	27	0.3	1.7	8	0.6	1.1
Baetidae(e.i.)	7	0.4	0.6	1	0.4	-
Ephemerella invaria g.	2	1.4	1.6	1	0.9	-
Tricorythodes	12	0.3	0.7	8	0.3	0.6
Heptageniidae(e.i.)	1	0.5	-			
Ephemeroptera(e.i.)	17	0.2	0.4	31	0.2	0.5

Appendix D.4 Head capsule width range measurements of macroinvertebrates of the benthic and drift samples from the second run (November 7, 1982) in Nine Mile Creek. (Min.: Minimum, Max.: Maximum, e.i.: early-instars).

	SECOND RUN					
		Benthic	Range		Drift	Range
Taxa	Sample Size	Min. (mm.)	Max. (mm.)	Sample Size	Min. (mm.)	Max. (mm.)
Simulium	16	0.4	0.9	22	0.4	0.9
Simuliidae(e.i.)				1	0.6	-
Isoperla	27	0.2	1.0	1	0.4	-
Hydropsyche simulans	32	0.5	1.8	8	0.5	1.6
Cheumatopsyche	9	0.5	1.1	1	1.1	-
Hydropsychidae(e.i.)	18	0.4	0.4	16	0.3	0.4
Hydroptila	10	0.2	0.4	5	0.2	0.4
Brachycentrus occidentalis	5	0.2	1.1			
Brachycentridae(e.i.)	2	0.2	0.2	1	0.2	-
Oxyethira	1	0.2	-			
Trichoptera(e.i.)	17	0.2	0.4	11	0.1	0.4
Baetis	17	0.6	1.1	4	0.5	1.1
Baetidae(e.i.)	12	0.4	0.6	8	0.4	0.6
Ephemerella invaria g.	2	0.6	0.6			
Ephemerellidae(e.i.)	3	0.4	0.6			
Tricorythodes	15	0.4	1.0	3	0.6	1.4
Heptagenia diabasia				1	1.9	-
Heptageniidae(e.i.)	2	0.6	0.6			
Isonychia	1	1.4	-			
Rhithrogena?	1	0.6	-			
Ephemeroptera(e.i.)	23	0.2	0.4	15	0.2	0.4